SOCIAL MEDIA INTEGRATION FOR OPEN SOURCE GIS APPLICATIONS

by

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April 09, 2013
Abstract
For a society faced with economic hardships, the funding and purchasing of new specialty softwares such as GIS are extremely limited. A geographic information system (GIS) is designed to capture, store, manipulate, analyze, manage, and present all types of geographic data. Due to the telecommunication technologies today, a GIS is not restricted to the traditional automated cartographic program or geographical analysis software used for intense scientific analysis. Modern GIS has evolved much like the current generation of society and technology. Today’s GIS manifest in many forms, whether in traditional desktops, mobile platforms, web maps, or in the cloud: GIS can be utilized anywhere. GIS has progressed into a versatile, informative science that provides an operational foundation for an organization instead of just a few geographers. An evolving capability that is becoming relevant to GIS is the integration of social media. This study illuminates free technologies which are currently available to the geospatial community and how their flexibility for user development allows these tools to be complimented with existing capabilities providing additional benefits for current applications. As GIS expands into different organizations, a need for an economically affordable but yet fully versatile GIS has evolved. In response many software manufacturers and others have begun to release open source geographic information systems. Open source software (OSS) is computer software that is available in source code form. This study conducted a simulation demonstrating the integration of GIS and social media. The simulation displayed the effectiveness of integrating ArcGIS Explorer Desktop and Twitter. This capability has demonstrated the power and usefulness of combining communication platforms and
geographical information systems. This thesis also focused on the capabilities of using open source GIS platforms which are of much less cost than commercial products while calling attention to the differences between commercial software packages and free open source applications.
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LIST OF ACRONYMS

# - Hashtags

2D - Two Dimensional

3D - Three Dimensional

CB - Citizens Band

ESRI - Environmental Systems Research Institute

GDG - Geospatial Data Gateway

GIS - Geographic Information Systems

GISc - Geographic Information Science

GISci - Geographic Information Science

GIScience - Geographic Information Science

GNU GPL - General Public License

GSM - Global System for Mobile Communications

OSS - Open Source Software

PHP - Hypertext Preprocessor Language

PPGIS - Public Participation Geographic Information Systems

SNS - Social Networking Sites

USDA - United States Department of Agriculture

XP - Windows XP Operating System
Chapter 1

Introduction

A. Introduction

For a society faced with economic hardships, the funding and purchasing of new specialty softwares such as GIS are extremely limited. Are there other options available to obtain these expensive types of software? A geographic information system (GIS) is designed to capture, store, manipulate, analyze, manage, and present all types of geographic data. GIS can vaguely be summarized as a combination of cartography, statistical analysis, and database technology (Wright, Goodchild & Proctor, 1997). GIS allows us to view, understand, question, interpret, and visualize data in many ways which reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts. A GIS helps answer questions and solve problems by looking at data in a way that is quickly understood and easily shared. GIS has evolved and become more readily available over the past decades. These information processing tools have advanced the capabilities of the geospatial community. These capabilities have also become available in the form of free or open source GIS technology due to these advancements. It is important for GIS to adapt and evolve not behind the technological and societal curve, but along with it.

Society today is constantly on the go and work seemingly never ceases. Technology allows users to access infinite amounts of information whenever or wherever they wish through remote desktop configurations or via mobile devices. The current generation of society and technology is capable of maintaining constant contact with individuals widely dispersed through multiple means of communication. The majority of
society is mobile and never disconnected. From the telecommunication technologies today, a GIS is not restricted to the traditional automated cartographic program or geographical analysis software is used for intense scientific analysis. Modern GIS has evolved much like the current generation of society and technology. Today’s GIS manifest in many forms, whether in traditional desktops, mobile platforms, web maps, or in the cloud; GIS can be utilized anywhere. GIS has progressed into a versatile, informative science that provides an operational foundation for an organization instead of just a few geographers. Geographic information sciences (GISc, GISci, or GIsScience) are the academic theory behind the development, use, and application of geographic information systems (GIS).

As GIS expands into different organizations, a need for an economically affordable but yet fully versatile GIS has evolved. In response many software manufacturers and others have begun to release open source geographic information systems. Open source software (OSS) is computer software that is available in source code form. The source code and other certain rights normally reserved for copyright holders are provided under an open source license that permits users to study, change, improve, and in certain circumstances, also distribute the software (Ramsey, 2007). Open source GIS software is specifically for GIS applications.

An evolving capability that is becoming relevant to GIS is the integration of social media. Twitter, a common example, is a social media platform that can be used beneficially to share, communicate, and interact with a GIS. Twitter can integrate its “tweets” messages in to a GIS when the user allows geolocation information to be shared from within the web platforms settings menu. The geolocation option embeds the latitude
and longitude of the user at the time the message was composed. Other social media platforms such as Facebook, Foursquare, and GyPSii also have these capabilities when enabling and embedding geolocation information in post.

With an evolving technological based trend currently under way, a geographic platform integrated with social media for a communication and information sharing is much needed. Such a development would not only benefit corporate organizations but individuals as well. The applications of this capability are beneficial to many sectors and like many open source GIS platforms, capabilities can be customized to meet users or organizational functional needs.

B. Statement of Problem

This study illuminates free technologies which are currently available to the geospatial community and how their flexibility for user development allows these tools to be complimented with existing capabilities providing additional benefits for current applications. Whether to purchase commercial grade software or to use free open source GIS technologies is a decision which has to be made by everyone in need of a GIS. By examining and comparing the commercial softwares relative to the open source softwares, limitations and capabilities can be determined.

Social media is a big contributor to the current communication trends of our technological based society. Social media is currently being utilized as both a business and individual communication platform. These social media platforms offer not only communication capability but can also act as a data sharing and personal expression mechanism which is possible through multiple forms of traditional communication means
instead of a single mechanism. Communication hurdles themselves seemingly have been bridged as society demands constant communication, but such a mobile society presents new hurdles. How do users understand or track from where the communication or data originates? Tying information to a physical location is where current communication platforms and GIS opportunities have arisen in today’s society. Contemporary social media platforms have coincidentally opened a window of opportunity for integrating both GIS and communication platforms. Utilizing and bridging free developable technology such as open source GIS and social media into current platforms could alleviate harsh fiscal burdens associated with dense proprietary based software and communication platforms. It is this need that provides the basis of the simulation found in this study. By bridging social media, like Twitter, with open source GIS, such as ArcGIS Explorer, a need for a solution to understand where data originates can be tackled.

C. **Significance of the Problem**

Today, many local and global economies are facing hardships. Wright, Goodchild & Proctor (1997), believe that the spread of geographic information sciences and its associated tools have been restrained from expansion because of numerous factors (Wright, Goodchild & Proctor, 1997): First, there is still a steep learning curve for the majority of workers who have never been exposed to the concept of GIS. A lack of interaction, knowledge, and willingness to embrace new technologies or change are major issues faced by the geospatial community. Furthermore, there is a significant financial expense to invest in a commercial seed GIS, since they often have large upfront costs. Many small businesses or municipalities do not have the means to invest in
commercial GIS software and the analysts to run and maintain such systems (Wright, Goodchild & Proctor, 1997).

The significance of this study is to educate and to inform the geospatial community and non-GIS users of possible ways to do geospatial work with free, developable, open source GIS applications. By using various techniques, and a combination of free technologies, it is possible to develop a GIS personalized to specific operational needs. Open source GIS applications give users a platform to develop personalized GIS applications. Data creation, manipulation, and analysis are possible when using open source GIS applications. Moreover, open source GIS platforms are robust enough to allow users to develop timely GIS applications offer such as the ability to use GIS platforms and social media as a means of communication, data capturing, and data collaboration. It is suspected that many people are using various independent technologies to do work today and possibly have not realized or been informed about the benefits of using a personalized GIS to maintain their workflow efficiently.

D. Statement of Purpose

This project investigates and tests the potential for incorporating social media into a GIS. The concept of this project was developed after tornados struck Alabama on April 27, 2011. On that day, Alabama experienced a violent tornado outbreak that consisted of 62 touchdowns across the state, 39 of which were in North Alabama. Lauderdale County and its neighboring counties were directly impacted by the tornado outbreak. Communities were left without power and most of telecommunication means for days and in some cases weeks. In the event of total destruction of infrastructure most plans for
response to a disaster are not viable. Automated call in functions were not working because the phone lines were down, and cell phone towers were severely damaged leaving them unable to provide enough service to complete phone calls.

However, one capability for communication that was not affected by the storm was short text messages. This was possible because of the way point to point messages are handled by the global system for mobile communications (GSM). GSM for point to point messages does not require a constant link up rate, like voice calls do, essentially messages ping the towers’ receivers until processed. Whether by text messaging, instant messaging, or social media messages this was the only means of communication available. How could they tie what little communication they received with a physical location? With responders and utility crews unable to communicate and share data, a need arose for a robust GIS and communicational platform capable of functioning despite catastrophic damage to electrical and telecommunication grids. In this situation, the integration of social media such as Twitter into a public management GIS could have been quite beneficial. Social networking sites (SNS) or social media therefore offers promise for communication platforms in the field of emergency management. Organizations can use social media as a way to network and collaborate, just as individuals increasingly do (White et al, 2009).

By integrating Twitter and ArcGIS Explorer Desktop, this project simulates how social media can be used to collect, inform, and spread information correlated with locational or positional data. Also, this project simulates the different types of messages functions which was observed and applied while using a free social media provider and open source GIS software.
E. Theoretical/Conceptual framework

This project is theoretically informed by several related literatures forming a compelling interdisciplinary intersection: geographic information sciences, geographic information system (GIS), open source GIS software, public participation geographic information systems (PPGIS), public domain software, GNU GPL, and proprietary software.

Public participation geographic information systems (PPGIS) are meant to bring the academic practices of GIS and mapping to the local level in order to promote knowledge production to the general public (Sieber, 2006). The concept driving PPGIS is empowerment and inclusion for marginalized populations who have public little voice through geographic technology education and participation (Sieber, 2006). PPGIS use and produce digital maps, satellite imagery, sketch maps, and many other spatial and visual tools, to change geographic involvement and awareness at a local level. PPGIS has metamorphosed into a co-produced concept composed of multiple disciplinary approaches and actors, rapidly changing technologies, and numerous goals. It is this reason that PPGIS has directly impacted the open source GIS movement. PPGIS research itself has undergone an evolution as participants seek to formalize the nature or process of PPGIS (Sieber, 2006).

PPGIS is not directly involved with the development of open source GIS applications but merely successful in education on the need for GIS capabilities. In return PPGIS has brought to light a need and the trending solution users are turning to are the open source GIS platforms. Thus PPGIS enlightenment is opening opportunities for not
only grassroots organizations, but also for commercial GIS organizations to diversify
their portfolio meeting a need for current and future use. Given an ever broadening range
of technologies, an effective PPGIS application depends on understanding how much and
when technology should be brought into a process.

One type of technology that might be brought into a process is public domain
software. Public domain software is not copyrighted, trademarked, or patented. Often the
term “public domain” is used in a loose fashion to mean free or available gratis.
However, public domain is a legal term that means not copyrighted. Under the Berne
Convention, which most countries have signed, anything written down is automatically
copyrighted. Therefore, if you want a program you have written to be in the public
domain, you must take some legal steps to disclaim the copyright on it, otherwise, the
program is copyrighted (Peters, 2012).

Another greatly different type of software that could be used is proprietary
software. Proprietary software is another name for non-free software, which is licensed
under exclusive legal right of the copyright holder. The licensee is given the right to use
the software under certain conditions, while restricted from other uses, such as
modification, further distribution, or reverse engineering (Nix, 2001). Most proprietary
software comes without the source code, which is the code originally written by the
programmer. Without this code you cannot easily change the way the software operates.
When you buy proprietary software, you are essentially buying the right to use the
software in a specific way. Advantages of proprietary software include: 1) reliable,
professional support and training available; 2) packaged, comprehensive, modular
formats; and 3) it is regularly and easily updated. The downside, however, is that it is: 1)
costly, 2) has closed standards that hinder further development (Peters, 2012). For these reasons the project in this study will focus on open source GIS and free social media platforms.

F. Objectives

The first objective of this study was to conduct a simulation demonstrating the integration of GIS and social media. The simulation demonstrates the effectiveness of integrating ArcGIS Explorer Desktop and Twitter. This study also helps call attention to the differences between commercial software packages and free open source applications. The growing body of literature dealing with the combination and integration of open source geospatial capabilities will serve as background for this study. Finally, it is anticipated based on the findings, that the geospatial community can understand the full capabilities of open source GIS and how its functionality and development could serve the current or future needs of the user.

Integrating Twitter into a GIS is possible when Twitter users enable the geolocation function in their user settings. The geolocation function embeds a latitude and longitude value in every tweet. Tweets are publicly visible by default, but senders can restrict message delivery to just their followers. Locational information is embedded from the GPS in one’s smartphone when tweeting from a mobile device. To view Twitter feeds inside of ArcGIS Explorer Desktop an “add in” is needed. “Add in’s” are applications that are specifically formatted to work inside of ArcGIS Explorer Desktop. Since ArcGIS Explorer Desktop is an open source GIS platform, developers can freely modify and release applications for the public to download and use. When using the
Twitter “add in” for ArcGIS Explorer Desktop, Twitter feeds appear inside the GIS geotagged on the map.

Second, this paper provides information about the open source and PPGIS movements and how they have greatly affected the geospatial community. The PPGIS movement has not only made progress in its efforts to educate communities on geospatial technology but has also indirectly caused progression in open source GIS platforms. Given this rapid evolution examined, this study examines the types of open source GIS technologies which are available, as well as common positives and negatives associated with each.

G. Assumptions

Initial assumptions are that the benefactors, users who benefit from open source GIS applications, do not have access to commercial GIS products and/or are searching for affordable alternative personalized GIS options. Assuming the benefactors do not have current funding for commercial software, it is fair to also assume they lack funding to have an adequate communication and information sharing platform. An information platform is a platform that can be used for communication, file sharing, or networking purposes. Also, it is assumed that the benefactors understand that combination and integration of these free, open source technologies might require coding or programming by a third party to bring about the full capabilities of the open source GIS and communication through social media integration effort.

For the simulation, it is assumed that GIS and social media integration is possible when using ArcGIS Explorer and Twitter. This capability is assumed to demonstrate the
benefits of using an open source GIS application in order to form a personalized GIS in order to meet the benefactor’s needs. Other assumptions are that the simulation will be conducted by using mobile devices to render locational based information while in the field. The scenario actions will also provide a detailed insight into an open source GIS program.
Chapter 2: Literature Review

A geographic information system (GIS) is designed to capture, store, manipulate, analyze, manage, and present all types of geographic data (Hsiang & Smith, 2011). GIS can vaguely be summarized as a combination of cartography, statistical analysis, and database technology (Wright, Goodchild & Proctor, 1997). GIS allows us to view, understand, question, interpret, and visualize data in many ways which reveal relationships, patterns, and trends in landscape processes. A GIS helps one answer questions and solve problems by looking at data in a way that is quickly understood and easily shared (Hsiang & Smith, 2011).

GIS allows the user to have the capabilities to collect, analyze, and publish information. GIS efficiently provides these capabilities for large amounts of spatial information. In practice, however, by virtue of its technical complexity and cost, GIS has traditionally only been available to government and public administration, where it plays a vital role in the majority of its daily operations. However, it has been effectively denied to most communities which lack the resources, time, and expertise to use this technology, even in western industrialized societies (Caldeweyher, Zhang & Pham, 2006). The drop in computer prices and the increased popularity of internet mapping in recent years has sparked the development of many projects with the aim of bringing GIS technology to the general public at little or no cost. Progress like this is what has allowed for the basis of this study and simulation.

Public participation geographic information systems (PPGIS) are meant to bring the academic practices of GIS and mapping to the local level in order to promote knowledge production. The concept driving PPGIS is the desire for knowledge and
intellectual progress of marginalized populations, who have little voice in the public arena, through geographic technology education and participation (Sieber, 2006). PPGIS use and produce digital maps, satellite imagery, sketch maps, and many other spatial and visual tools, to change geographic involvement and awareness at a local level. PPGIS pertains to the use of GIS to broaden public involvement in policy making as well as to the value of GIS to promote the goals of nongovernmental organizations, grassroots groups, and community-based organizations. PPGIS was originally defined as a variety of approaches to make GIS and other spatial decision making tools available and accessible to all those with a stake in official decisions (Caldeweyher, Zhang & Pham, 2006).

As costs decline for both hardware and software, costs for relevant high resolution data remain high. In developing countries, costs for all components are prohibitive, and GIS operator expertise needed to operate components may be scarce (Neteler, 2010). Fortunately, in the United States, grassroots groups and larger nonprofit organizations are largely able to implement GIS because they exist within a society that supports their GIS activities (Neteler, 2010). A framework of PPGIS consists of four key themes: place and people, technology and data, process, and outcome and evaluation (Sieber, 2006). A nonprofit intermediary sector has even emerged to assist the GIS needs of other nonprofit organizations and the public (Steiniger & Bocher, 2009). A resource-poor organization may be unable to afford GIS but can borrow a group member’s computer and install software donated by a vendor or acquire georegistered data from a free data portal. Also, the organization then has the opportunity to receive GIS training from a technical assistance organization that supports nonprofits which would then enable them to be
capable to print out a map on a plotter supplied by a public agency. The ostensible goal of
PPGIS is empowerment and the benchmark for a PPGIS project should be its
appropriateness, that is, its match with an organization’s existing activities, its
adaptability to local conditions, such as culture and climate, and its fitness to current
organizational capacity and overall goals.

PPGIS projects have tended to be guided by organized movements that use GIS as
a tool for capacity building and social change, not by esoteric academic interest
(Fotheringham & Rogerson, 2012). This current shift in PPGIS and the emergence of
open source GIS paradigm has allowed this change to include commercial organizations
adapting to a new paradigm scheme which is currently being driven by the geospatial
community. The use of GIS has been furthered by members of the public and private
sectors who believe that access to computer tools and digital data forms an essential part
of an information demanding society (Sieber, 2006). This concept is what has caused
advancement in open source GIS technologies, like ArcGIS Explorer, which is the
backbone of this project. Open source GIS has greatly evolved because of the geospatial
community’s need to share and advance the work of others under the legal right of open
source software. The availability of the source code and the right to modify enables users
to fine tune and improve the software. The right to redistribute these modifications and
improvements to the code, and to rescue other open source code by expanding and
debugging others’ work, adds to all the advantages to be shared by the geospatial
community (Fotheringham & Rogerson, 2012).

Recently, access to data has emerged as a growing area of concern in the
geospatial community. Access is variously defined as information about the policy-
making process, acquisition of the raw digital data being used to craft that policy, the supply of public information, or the ability to submit information into official data sets (Peters, 2012). Most spatial data available for PPGIS projects are created and maintained by the public sector. The limiting constraints that are being placed on the availability of spatial data represent a series of four competing ethics within an organized government.

First, open government data and information produced by the government is owned by the general public, and therefore, the data should be inexpensive and easy to access. Public data should be made readily available to the public through a number of different formats. Second, individual privacy of citizens is paramount and personal data information cannot be made public. Government under no circumstance should violate personal rights and should maintain the highest levels of scrutiny about safeguarding personal information which should not be released. Third, security of the state is a major factor and data that could critically compromise major infrastructure or the welfare of the general public cannot be made public. Lastly, the fiscal responsibility of government should be entrepreneurial in its approach to data acquisition which has a market value. It is government’s responsibility to obtain what it needs while weighing the cost and need before acquisition.

Through literature and various case studies it is a goal to demonstrate the types of GIS that have been developed for specific studies and how they benefited the user. Also, through literature and various case studies a goal is to inform about not only the types of free GIS technologies but the fields or study areas that could benefit from adopting a GIS.

Coincidently, the PPGIS movement has in turn caused evolution in the open source GIS arena, where it has forced demand for commercial GIS companies to provide
options to users who simply need to view or interact with geospatial data. Hence many commercial GIS companies today are producing free or open source GIS viewers in order to allow the opportunity for GIS to become an organizational platform among its users. This occurs because everyone does not need complete proprietary GIS, because some will just simply need the ability to view what others have produced. An example of an open source GIS program is *ArcGIS Explorer*, which is the software used in the simulation for this study. *Explorer* was produced by ESRI who is arguably the biggest GIS proprietary software provider in the world. This development was intended to bridge the gap between geospatial analyst and non-geospatial employees who just simply need to view and interact with the data in the business world.

When dealing with open source software (OSS) certain rights are normally reserved for copyright holders are waived so users can use source code to study, change, improve, and perhaps even distribute the software. Major open source GIS platforms offer powerful functionality, which are free from licensing costs and vendor lock-in, where vendor requires annual maintenance fees (Doolan & Needham, 2011). Current examples of open source software available today are *ArcGIS Explorer, CartoWeb, Grass, ImageJ, Jump, KOSMO*, and more. Frequently free and open source GIS software may be an option to offer the user a condensed, limited functioning, customizable, but affordable solution to meet the user’s needs. For the end user, the promise of open source is to receive quality software at a lower cost, which is flexible, interoperable, and free of any vendor lock-in. Open source GIS software packages are developed following this philosophy (Doolan & Needham, 2011).
Open source software can be used in commercial projects by for-profit companies offering a variety of related services. The important open source GIS software packages are interoperable and follow industrial standards for data exchange. The geospatial industry has started to integrate open source GIS libraries into their proprietary products to improve their interoperability capabilities. Additionally, and in contrast to dominant proprietary GIS software packages, open source GIS are portable, that is, they can be operated on various computer operating systems. Open source GIS software packages offer functionality comparable with proprietary GIS. As in the traditional industrial market, general purpose tools and specialized applications are available (Neteler, 2010).

Open source components showcase, not only the level of sophistication open source GIS products have reached in recent years, but more importantly, that GIS should no longer be considered an elitist technology. Now there exist feasible low cost means of providing grassroots organizations with access to information which they have historically been denied because of technical complexity and the high cost of traditional GIS (Doolan & Needham, 2011). Open source software has the advantage of: 1) low cost and no license fees; 2) open standards that facilitate integration with other systems; and 3) it is easily customizable. The downside is: 1) lack of professional support; 2) evolving developer communities; 3) lack of release co-ordination; and 4) erratic updates. However, with such a large development and user-base, many discussion forums and help sites are available for users (Peters, 2012). Because of this, the growth of open source software has been remarkable worldwide (Pucher, 2003). Open source software can provide a feature-complete alternative to proprietary software in most system designs (Ramsey, 2007). This can dramatically increase the impact of open source software allowing it to
benefit developing nations. Combining OSS with the technical workforce available in developing countries can enable technology transfer. Of course, information technology, and open source in particular, is not a silver bullet for long standing development issues; nothing is (Doolan & Needham, 2011). But the transformative potential of computing does create new opportunities to make progress on development problems that have been intransigent (Doolan & Needham, 2011). Promoting open source GIS applications can provide technology-challenged areas the opportunity of enlightenment for a societal advancement and technological paradigm change.

Open source GIS software can be categorized into a few largely independent development tribes. Within each tribe, developers cross pollinate very heavily, contribute to multiple products, and have high awareness of ongoing developments (Ramsey, 2007). There are four main tribes: C tribe, Java tribe, .Net tribe, and the wild cards. It is important to understand what tribe your application is developed off of in order to customize in the future. If your existing systems work off of one tribe you want to get an open source GIS that is based off of the same language. This is very beneficial when trying to integrate your existing systems to a new system.

The C tribe consists of software that is based off of the C programming language. The C tribe also includes scripting languages that bind easily to C libraries, such as Python, Perl, and PHP. The C based projects in general are more mature than the Java and .Net programs mainly because this language has been in development for a longer time to attract development communities. Shared libraries across various C-based applications allow applications to easily add features which would ordinarily involve a great deal of implementation. Applications that are C-based consist of server-side
applications and client-side applications, analytical tools, and display tools (Ramsey, 2007).

While the C tribe is based off of the C programming language, likewise the Java tribe is based off of the Java based languages, and the .Net tribe of course is based off of the .Net programming language. However, .Net has the advantage of being able to re-use code from both the Java and C arenas. The family of .Net projects are still relatively small, and their interlinkages are only just being made. However, by building on the libraries of C and Java communities, the .Net community has laid a solid base to build. Applications in the .Net world are not currently tightly bound to the work that has been done at the library level (Ramsey, 2007). All languages that do not fall into these categories, fall into the wild card tribe, which consist of all projects that do not fall into language bins such as web applications or mapping servers. Web projects are in abundance and have spread beyond their initial development stage into a stage of wider community use and maintenance.

Web projects are often grouped into two categories: toolkits and frameworks. Toolkits are more modular and can easily integrate into a custom application. The frameworks which can be deployed and run off of the shelf packages, but are more suitable for customization than integration (Ramsey, 2007). ArcGIS Explorer Desktop is an exception because of its design and functionality. ArcGIS Explorer can be classified in certain circumstances as a framework, running off of the commercial and proprietary ArcGIS platforms, but was created as a customizable viewer that also has the capability of incorporating into a web project through ArcGIS Online. This functionality of ArcGIS Explorer, which is what was used in this project, is theoretically a toolkit. It is classified
as a toolkit because of the application in which this project deployed a custom developed Twitter based application that is built on top of the open source platform. By incorporating Twitter, an online social networking sight, in this instance ArcGIS Explorer would be classified as a toolkit.

Online Social Networking Sites (SNS) are becoming extremely utilized and can be employed in a variety of contexts. Emergency domain related websites, each with their own stated missions, are becoming widespread. A broad definition of SNS is a web-based service that allows individuals to do the following: First it constructs a public or semi-public profile within a bounded system. This allows for communication groups or contact profiles to be created to ease communication once implemented. Secondly, it articulates a list of other users with whom they share a connection. By having these predefined groups, which can be shared and distributed, lack of contact information will not be a likely issue. Third, it views and traverses their list of connections and those made by others within the system. By connecting with others and gaining access to their connections and users, essentially networks shift from many individually isolated networks into a mainstream interconnected network index (White et al., 2009). This proved to be extremely valuable during the simulation in this study because of the ability to contact and connect with other users by accessing connections that were already listed and defined in the system.

Before embarking on the design of such a social network, it is critical to examine critically current social networking sites and how the emergency domain is presently using them. Also, it is essential to engage emergency management personnel and their organizations in dialogue to determine their needs, and how to best serve them (White, et
al, 2009). Because of these, the simulation conducted in this study consisted under the basic framework of allowing data sharing and communication to occur across a single platform in order to better understand conditions in the field.

In conclusion, the literature has demonstrated the advantages and capabilities of not only open source GIS but also social media platforms. These fields have evolved not only because of technology and society’s adoption of the capability, but because of movements across government and academia such as the PPGIS and SNS movements. This PPGIS concept is driving the desire for knowledge and intellectual progress which has inadvertently gained momentum in not only informing about the platform capabilities GIS can offer, but has enticed commercial proprietary companies to release free and open source programs to provide larger embracement of the science across the organizational platforms. This open source mindset allows for constant progress and development through further research and sharing of source code which progresses not on the application but benefits the whole geospatial community. It was developments like these which allowed for the integration of open source GIS, like ArcGIS Explorer, and social networking sites, such as Twitter, which are the basis of the project found in this study.
Chapter 3: Methods and Procedures

This project investigated the capabilities of incorporating social media into a GIS. The concept of this project was based on criteria that most of North Alabama found itself in after the April 27th, 2011 tornado outbreak which crippled most of the Southeast. There were 358 tornados that traveled across the United States during this outbreak which killed 324 individuals, 238 of which were in Alabama. During this time many Alabama counties had limited power available to the general public. Also, telecommunications were affected and land lines had no connectivity. The only means of communication were by public broadcast made over the radio and by smart phones. Conditionally, cell phone towers were still operational but badly damaged, although there was not enough service to place phone calls, the towers still allowed for data packages to be accessed and for text messages to be sent. This allowed smart phone users to be able to access the internet, which in exchange allowed them to communicate with others through email and social media websites such as Twitter.

It was determined that most emergency readiness plans were dated and inefficient during a disaster of this magnitude. Most of the plans relied on using firsthand accounts of workers in the field trying to relay messages back to a dispatch station. CB radios were ineffective because most of the repeaters throughout the counties were destroyed. Plus, there was not enough cell phone service to place phone calls.

So in the aftermath of the storm, emergency management and utility officials all seemingly had to work independently because there was not a platform in which they could readily exchange information to a central point of contact. Crews linked up for a debriefing at the beginning of every day, but after that communications ceased. This
made the storm damage much more devastating by slowing recovery progress and by preventing a clear understanding of local circumstances within the regional problem. Due to this, most communities in North Alabama had curfews, both to prevent looting and because of the many hazards on the ground. Another step communities took was blockading the roads to keep people from coming in. There were people trying to view damage, but there were also people trying to come and help. There was no obvious place to begin cleanup while the pressing issue was search and rescue and the evacuation efforts.

With virtually all infrastructure destroyed, communication was limited to social media posts and text messages from mobile devices. In this situation, could integrating a social media such as Twitter into a GIS be beneficial? What was once a conceptual idea has now shifted into the framework of this project. Social networking sites (SNS) or social media offer promise for communication platforms in the field of emergency management. SNS are becoming popular because of user familiarity and the popularity amongst users. Organizations can use social media as a way to network and collaborate (White et al, 2009).

A. **Population and Sample**

The site chosen for this study is Lauderdale County, Alabama. Lauderdale County is approximately 667.70 square miles as of 2010 with an estimated population of 92,781 as of 2011 (Battle, 2007).

Lauderdale County, Alabama is named in honor of Colonel James Lauderdale, of Tennessee. Col. James Lauderdale was born in Virginia around 1780 in the early 18th
century. As a lieutenant colonel, he commanded a brigade of riflemen while serving under Andrew Jackson fighting in the Creek Wars and against the British in the Battle of New Orleans. Lauderdale County was established in 1818, one year before Alabama became a state. Lauderdale County is one of several counties commonly referred to as “the shoals area” (Haddix, 2011).

B. Setting

Lauderdale County was chosen as the study area for this thesis because of my familiarity with it. I spent the majority of my life living in neighboring Colbert County. Also, I spent a large part of my time in Lauderdale County completing my Bachelors of Science degree at the University of North Alabama in Florence. Another factor that led to the study area being Lauderdale County was the available data that I have acquired over the years from previous employment and educational studies.
Figure 1: Lauderdale County, Alabama.

C. Data Collection Process

ArcGIS Explorer Desktop (See Figure 2) is a free GIS viewer which allows users to explore, visualize, and share GIS information. ArcGIS Explorer adds value to any GIS because it helps one deliver authoritative data to a broad audience. Benefits of Explorer are the availability of being able to use ArcGIS Online data such as base maps. ArcGIS Explorer is easy and intuitive to use and also allows one to add local data. The viewer is capable displaying both 2D and 3D. Other functionality of Explorer allows one to create custom presentations. ArcGIS Explorer is customizable using centrally managed application configurations with no programming required. This allows users to develop and create their own tools. Using ArcGIS Online these customized tools can be posted by
the developer and downloaded for others to use. *ArcGIS Explorer* is capable of working fully localized while still being able to control all user interface elements. This means that *ArcGIS Explorer* is capable of working off of a mobile media device and without an internet connection. *Explorer* is available in multiple languages such as English, French, Japanese, Chinese, German, or Spanish. *ArcGIS Explorer Desktop* is supported on the following platforms: Microsoft Windows 7, XP, Vista, and Server. *ArcGIS Explorer* is JAVA based and developed as a freeware by ESRI.

![Image of ArcGIS Explorer](image)

**Figure 2:** ArcGIS Explorer is a free GIS viewer.

This project, for example, used *ArcGIS Explorer* as the GIS platform for integrating GIS and social media. *ArcGIS Explorer* was chosen because it is open source and is easily developable. For instance, this project uses the Twitter “add in” for *ArcGIS*
This was a custom application built and released for public use by its developer. The purpose of this application is to integrate Twitter feeds into ArcGIS Explorer based on geolocation.

Twitter is a free, platform-independent, Web 2.0 communication application that allows users to send short (up to 140 characters) electronic messages to other individual users and user groups. Twitter users can send messages to one another via most internet-enabled devices capable of text messaging. This new and unique service offers great potential for rapid and integrated response to disasters (Mills, 2009). Tweets contain precise and relatively accurate information about when they were posted. They can contain precise and accurate “where” location information as well if the tweet comes from a GPS enabled device for which the user has opted for geolocation (MacEachren, 2012). Using Twitter as input to a geographically-enabled crisis management system requires less explicit geographic information to be extracted as well, e.g., the location stored in user profiles, place references extracted from tweet content, and hashtags that are associated with places. Hashtags are a word or phrase prefixed with the symbol #. Hashtags acts as a form of a metadata tag that often symbolizes groupings in message chains. Attribute information in tweets is challenging to extract due to the combination of the 140 character limit on tweets (which prompts extensive use of abbreviations (MacEachren, 2012).

Twitter was launched in July 2006, beginning as an intra-company experiment at Obvious Corporation as a research and development project with the thought of aiding coworkers to communicate at work. It remains one of the San Francisco Bay Area’s most famous Web 2.0 start-ups. Twitter was achieved by essentially combining blogging,
instant messaging and short messaging service (SMS). Twitter was not intended or designed for high performance communication, but the idea that it could be used for emergency communication certainly was not lost on the originators. Twitter has become a form of an “open-source” news network. With Twitter working in tandem with SMS, information and communication becomes mobile. By combining people at their computers with people on the move on their cell phones and PDAs, Twitter facilitates real-time group communication that never existed before (Mills, 2009). Twitter and other social media are potential sources of information that can be analyzed to support a wide array of monitoring and decision-making activities. The crisis management community has recognized the potential value of social media as both a tool to monitor rapidly evolving situations and to disseminate information (MacEachren, 2012).

The data collection process consisted of data creation from in the field simulations. These field simulations were from the scenario participant who gathered, collected, and tweeted messages from a mobile device throughout Lauderdale County. An ideal situation would have been to have multiple users in the field simulating and sending tweets while also having a so-called base station at a remote site with an internet connection. This base station would be where the user with ArcGIS Explorer is monitoring the Twitter traffic in the integrated Twitter application inside Explorer. This would have allowed for real time tweet traffic and monitoring for the base station at the same time. The social media or tweets can occur from anywhere with cell phone service if being sent from a mobile device; however, they cannot be received inside of ArcGIS Explorer unless there is an internet connection. Explorer will receive the tweets and be able to geotag the tweet location from the coordinate embedded and enabled in the tweet.
Being successful means being able to handle tweet information from multiple users simultaneously could prove to be an effective free open source GIS-based means for communication, data collection, and data sharing.

Instead, data was simulated by having multiple Twitter accounts, which the user rotated, in order to demonstrate the ability to simulate multiple users. From designated sites within Lauderdale County, tweets were created and sent. The tweets contained a text message, image, and a geographic tag. This process was repeated multiple times under multiple Twitter accounts. This was done in order to simulate communication and data sharing capability that is real time and geoaccurate. As multiple simulation tweets were made and Twitter was synced, the Twitter account inside of ArcGIS Explorer began receiving messages. These messages appeared as the map synced with the Twitter account that was integrated and added into Explorer. This can happen in real time or during post-processing depending on the network connection status. Some basic vector layers were already obtained from local utility companies. These vector files display electrical, gas, water, and waste water lines. County level 10 meter resolution imagery and road data was obtained along with population data. The imagery and road data used in this scenario was downloaded from the United States Department of Agriculture (USDA) Data Gateway. The Geospatial Data Gateway (GDG) provided by USDA is the one stop source for environmental and natural resource data. Orders are free and are placed by state or county level request. The population data was from Tiger files.
D. Data Analysis

By integrating Twitter and ArcGIS Explorer Desktop, this project simulated how social media such as Twitter can be used to collect, inform, and spread geospatial information while in the field. The different types of messages or purposes observed can be applied while using a free, social media provider and free, open source GIS software. A simulation was conducted by sending various themed messages from a variety of locations within Lauderdale County. Locations consisted of critical infrastructure, hazards, storm damage, utility sub stations, major intersections, historical locations, and other points of interest from within Lauderdale County.

Now that this method has proven successful in Lauderdale County, Alabama, there is no reason why the scope of this project could not happen at a wider level such as state, national, or global level. Perhaps being able to use a free and open source GIS program and a free social media network could prove useful in the event of disaster or extreme circumstances to places where no GIS or emergency management infrastructure are in place. Using smart phones, free social media, and free open source GIS areas could possibly implement and maintain a geospatial communication platform instantly with minimum infrastructure.

E. Limitations

The study only had the capabilities of testing with limited input for analysis. Another limitation was the lack of assistance in creating and maintaining simulations. This study did, however, develop a prototype example that was tested creating several simulations. The goal of this prototype was to demonstrate how ArcGIS Explorer and
Twitter can be used as an organizational platform. This platform was able to view and capture geographic data while also providing users the capability of sharing messages and pictures that are geographically correlated and usable. This allowed for the tracking and sharing of information from in the field to virtually anywhere in the world.
Chapter 4: Results

A field scenario simulation was used in order to generate results for this study to investigate the possibility for transmitting data back into a central GIS for officials to use in understanding damage and to help dispatch recovery efforts in times of disaster. Results from this field simulation scenario suggest that it is possible, using social media and an open source GIS a communication platform. Twitter, a social media service, allows users to send short messages and small files that can be georeferenced by allowing location to be embedded in “Tweets” and by enabling the GPS on the user’s smart phone. How to enable location can be viewed in Figure 3.

![Twitter settings](image)

**Figure 3:** From the settings option inside the user’s Twitter account a simple check in the box will enable Twitter to add location.

This allows the user to send short messages or to share a picture with other followers on Twitter which is georeferenced to a specific location. By setting up who you follow and allowing others to follow you, a private communication network is created. Who you follow is essentially the user defining and connecting to other Twitter users or contacts they wish to receive messages from. An example of this can be seen in Figure 4.
Figure 4: Figure 4 demonstrated how the user @ThesisResearch1 is following @ThesisResearch2 and @ThesisResearch3.

By using ArcGIS Explorer, a GIS, and the Twitter “add in”, Twitter feeds from multiple users can be viewed at geoexact locations on the map. The field scenario used for this thesis consisted of using three Twitter accounts and ArcGIS Explorer. The Twitter accounts used for this scenario were @ThesisResearch1, @ThesisResearch2 and @ThesisResearch3. These three accounts were in the field surveying and reporting anything of interest. Another user can monitor their finds as they are “Tweeted” from the field. This is possible because Explorer accepts Twitter feeds through the Twitter “add-in” and plots them onto the map using the embedded location information. The county-wide results of multiple Twitter feeds this field scenario created can be seen in Figure 5.
Figure 5: The image displays the major roads of Lauderdale County in red and the Twitter feeds plotted by location.
**Figure 6:** Image displays all roads in green, major roads in red, and all other symbols are Twitter messages.

Twitter feeds do not have to occur inside of ArcGIS Explorer. They can also be viewed by logging into your Twitter account on the web. When on the home tab of your Twitter account, tweets from the user’s account and those of his followers appear in chronological order. This can be seen in Figure 7 which displays the recent Twitter feeds from @ThesisResearch1’s account. This is beneficial to the other users who are out in the field because they can view the messages and monitor progress if they are following the sender’s account.
Twitter users can assign themselves a custom or personalized symbol. This is commonly referred to as their header. This custom icon is the symbol that ArcGIS Explorer assigns as the point symbology when it is incorporated into the map. Double clicking the symbol on the map opens the message for the user to view. If there is a photo attached there will be a customized address link that is accessible from the Twitter account.
message. These messages allow for sharing data and communication but allows for an added benefit since it is geotagged allowing others to understand where it comes from as well. This can be seen in Figure 8, which demonstrates how to view Twitter messages inside of Explorer.

Figure 8: The image displays the custom message that the user tweeted as well as the attached image that correlates to the message.

Once you open a message feed, a call out box indicates place of origin by linking the callout to a specific point. This is important to maintaining spatial accuracy. Some points may seem to overlap due to scaling. This is possible if multiple points originate from a single location. However, this scaling issue will generally resolve itself as you zoom in closer to the cluster of points.

For this scenario, zones were created and applied in order to show each individual who was conducting the survey in their own core area. By assigning zones or core areas
to a unique Twitter account, a thorough examination of Lauderdale County can occur. This is much more efficient than surveying without a plan or core area. Zone areas may seem disproportional but a lot of factors contribute to their designation. Some factors include the amount of area in a zone, its population, or its amount of infrastructure. Other external factors could also exist such as the amount of damage caused by a storm. Some areas will naturally be hit harder than others in the event of a disaster which would require longer amounts of survey times in order to report all major issues or hazards. An example of how this scenario divided off Lauderdale County can be seen in Figure 9. The county was primarily divided by the major roads in Lauderdale County.

![Figure 9: The image displays the assigned zones in Lauderdale County.](image-url)
In Figure 9, there are three zone categories visible. The areas in green were assigned to @ThesisResearch1. These areas cover most of the west of Florence going out Savannah Highway and areas to the North along Helton Road. The areas in purple were assigned to @ThesisResearch2. The primary focus of @ThesisResearch2’s zone was Cloverdale Road, downtown Florence, and the southeast portion of Lauderdale County along Highway 72. The areas in yellow were assigned to @ThesisResearch3. The yellow section in the west part of the county is the Natchez Trace, and the area in the northeast part of the county. By sectioning off the county, it effectively improves survey time and quality ensuring that no core areas are overlooked. Also, it eliminates one area becoming over-surveyed when other areas still have to be surveyed.

An electrical utility could use this technology when in the field. They could take pictures of a broken pole and all of its assemblies and tweet it to the warehouse. Then the people in the warehouse could gather and dispatch all of the required equipment without an engineer having to go out into the field and note what equipment is needed. This would allow the engineer to stay on site and to develop a plan of action on how to fix the problem while the equipment and crews respond.

As Twitter feeds were received from in the field, ArcGIS Explorer was able to ingest and plot the messages based on the location information which is embedded in the messages, the results seemed positive. However, there were some limitations which were observed. First, one cannot send high megapixel images, as Twitter will not send images larger than one megapixel in a tweet. However, after examining the quality of the one megapixel images, it was determined sufficient enough to capture the field of view. The major issue noticed from the scenario was dropped tweets. In areas of no data service,
Twitter would still allow you to send the message. If you do not reach an area of service before the message times out, the message will be lost. In these circumstances the tweets get lost in space because the user does not receive a warning message nor is the message saved to drafts. This problem was noticed along areas of the southern part of the Natchez Trace which can be seen in Figure 10 below.

**Figure 10:** Areas in orange were areas that were found to have not data service.

After noticing the messages were no longer in existence they were recomposed and resent from another location. A major disadvantage is that the location value is now from where you resent the message and not from where it originated, as displayed in Figure 11.
Figure 11: This image displays a cluster of three points that did not send from their original location due to lack of cell data service.

Alarmingly, this is a major concern because users can send a tweet and it will simply not come through. The message acts as if the tweet never existed since it is not stored in the sent or draft messages windows. It is important that the users are aware of this limitation, because if they are not this could lead to data exchange issues. This limitation is one that can be avoided as long as the user maintains awareness to the amount of service available when the message is tweeted. In messages where there is not enough service, an important consideration should be to include a descriptive location in the message so that once the message is sent and received the reader will understand that the message is for another location.

This scenario was specifically geared towards operating under the same conditions that occurred during the April 27th tornado outbreak, for which it is beneficial
to disaster recovery efforts but not limited strictly to them. This type of application could be beneficial to many fields such as utilities, law enforcement, first responding service, or even small business that focus on services. Imagine witnessing a car accident and being able to tweet images of the crash to a 911 operator. The operator could then share that information with the police who would now know how many cars are involved in an accident. Also, the fire department could benefit because they would be able to see what condition the automobiles are in and start planning how to possibly extract injured victims while in transit to a scene. Also, it would be very beneficial because vehicle accidents don’t always happen at an intersection or right beside a mile marker which allows for precise location information to be given. If the tweet has the location embedded the 911 dispatcher could better direct first responders to the scene of the accident.
Chapter 5: Discussion

Open source GIS was a good choice for this study because of its ease and customizable interface. *ArcGIS Explorer* is free and available for public download from ESRI which is a huge benefit to users who cannot afford a commercial GIS application. *ArcGIS Explorer* has a friendly interface which allows the user to be able to understand and to begin to operate it rather rapidly. The interface has a ribbon toolbar which is similar to most Microsoft programs on the market today. This familiarity is one of the major factors that allow the user to quickly adjust even those with minimal GIS experience. Open source GIS applications give users a platform to develop for personal GIS needs. By using various techniques, and a combination of free technologies, it was possible to develop a personal GIS for this project. Using an open source GIS and social media integration allowed for data creation by allowing the user to capture an image, enclose a message, and imbed locational information. The data was then manipulated into a viable and viewable format which allowed the user to view and interact with the data. Performing analysis was also possible when using an open source GIS application like *ArcGIS Explorer*, by adding other vector data we were able to spatially analyze patterns along major roadways and other critical infrastructure which can yield valuable information.

The simulation completed in Lauderdale County presented valuable insight into the feasibility of this sort of application. The scenario examined major forms of infrastructure such as roadways, bridges, and utility equipment. Also, the scenario examined cultural, historical, and architectural features along with environmental hazards.
that were presented at the time of the scenario. The results and accomplishments of this paper prove a capability that could be implemented or utilized for a plethora of situations. The ease of data collection demonstrated a maximum operability which allows valuable insight to real-world conditions that may be occurring out in the field. Also, navigating, interacting, and interpreting Twitter fed information inside of ArcGIS Explorer offered numerous benefits by being able to interpret and interact with the data while maintaining spatial accuracy and locational data origination. Displaying where the locational data originated provided a much needed accomplishment when trying to understand not only the physical origin of the data, but to also understand previous communication limitations before social media was integrated into GIS. The open source customizable application used in this scenario is effective and offers users a fiscally affordable solution to meet the individual or organizational needs.

Using Twitter inside of ArcGIS Explorer was very constructive and operative. The tweets synced into Explorer displaying pin-point accuracy. By receiving messages inside of a GIS there was no miscommunication to occur as when using other communication mechanisms that have to be interpreted and plotted before their message can be examined. The most important part about a message is understanding where it came from and what it is discussing. Trying to relay this information often allows for error and miscommunication. When a message is received inside of Explorer however, it is tied to a physical location on the ground. This allows for the message to be interpreted, analyzed, and acted on because there is no need to translate and plot a location displaying the message origination because this is done on the fly.
The limitations of Twitter observed in this scenario would be of minimal concern in view of the study’s overall success. This project demonstrated that the capability of integrating social media into a GIS is possible and offers numerous benefits. One issue that was noticed while acting out the scenario was the inability to send high megapixel images. A noteworthy feature of Twitter’s functionality is that in the event of using too many characters in the body of the message, Twitter will not allow the user to send the message. Twitter warns the user how many characters must be removed. Lauderdale County offered areas with and without data service which provided key transmit characteristic information to better understand how the capability works in adverse conditions.

A major issue noticed from the scenario was dropped tweets. In areas of no data service, Twitter would still allow the user to send the message. A major drawback is that if you do not reach an area of service before the message times out, the message will be lost. In these circumstances the tweets get lost in space because the user does not receive a warning message saying that the tweet was not sent nor is the message saved to drafts.

These limitations are very inconvenient but are not mission critical and still allowed for the scenario to be carried out. A workaround is simply to compose the messages which need to be sent and make sure to include a location description in the message and save it to drafts. Then once the user reaches an area with data service the tweets can be sent. It is important to understand that the message will be attributed to the location of where the tweet is sent from, not where it was originated. This is why it is important to include a note of actual location in the message so that these points can be interpreted accurately. Understanding a limitation and its cause is very important, as
demonstrated by the scenario; tweets can still be sent when data service is temporarily unavailable if the user is aware and makes a slight adjustment to the collection method.

Continued and future studies should be implemented expanding the parameters of this scenario to allow for a wider user base and incorporating larger regional areas. Other industries such as small businesses should investigate the benefits and application of this technology. It could be used to track employee status as they move from one job to another. If they are an air conditioning repair company they could send a message saying job number 32 is complete and that would indicate a location, time, and date the job was completed. If the job wasn’t complete they could send a message of what the issue is or what is needed to complete the job at this location. This reflects utilizing the compounded finalized process of receiving Twitter feeds from within Explorer.

Also, future study should investigate the possibility of ingesting open or public Twitter feeds from individuals with public viewable account network profile information enabled. This means incorporating users who are not in the predefined contact list. These type of users have an open profile in which they share all their post with the global SNS population. Incorporating these type users could lead to tremendous results; these individuals would consist of other Twitter users who are not part of the scenario or following/friend list. Being able to incorporate messages from outside sources could possibly be beneficial in certain scenarios.

Likewise if scenario users posts are publicly shared in future scenarios, results could be interesting to see if others from outside of the scenarios’ defined constraints join the thread and contribute to the scenario efforts. Intense research would need to be completed in order to understand how to possibly filter inappropriate or unusable tweets.
from these outside individuals. As their contributions may yield to be inappropriate or off

Ingesting trending topics could be a possible grouping method for future studies. This could be accomplished by incorporating or sorting by multiple hashtags which would need to be inserted into future scenario’s messages relative to different subject matter categories. Hashtags act as a form of a metadata tag that symbolizes groupings in message chains. This project does not portray all possible uses for which allows future studies to investigate ways to better utilize and expand on this studies accomplishments. It was the focus and intent of this study to merely demonstrate and prove the capability of integrating open source GIS and social media.

This capability has demonstrated the power and usefulness of combining communication platforms and geographical information systems. This thesis also focused on the capabilities of using open source GIS platforms that are of much less cost than commercial products. Also, this thesis demonstrated the ability of using social media as a communication platform inside of a geographic information system. Most social media is also free of cost, but more importantly it is familiar and readily available to the public. If trying to implement this type of capability in event of a disaster, an easily accessible and familiar interface is very beneficial in getting individuals to use and benefit from the capability. ArcGIS Explorer and Twitter have demonstrated the capability and benefit of combining social media and open source GIS.
Works Cited

    <http://quickfacts.census.gov/qfd/states/01/01077.html>.

    webcommunity information system. International Journal of Geographic
    Information Science, 885-898.


Fotheringham, S., & Rogerson, P. (2012). Gis - open source initiatives. GIS Using Open
    Source, 1-12.

    museum>.

    <http://www.esri.com/about-esri/about/history-more.html>.

    GeoTech, 1-18


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