Using Technology to Protect Cities from Floods: A Case Study of New Orleans

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Executive Summary

As the effects of climate change continue to increase in severity across the world, low-lying cities will become ever more prone to floods. New Orleans, LA is well known for being vulnerable to severe flooding. Urban planners in New Orleans will need to use various technologies to figure out how to best protect their city from future floods. This involves learning which districts are the most susceptible to flooding, and those districts' characteristics. Not only can GIS be used to accomplish this, but other similar technologies can be used as well. Despite the many strengths of using such programs, doing this also has its drawbacks.

Firstly, various scholars' conversations were analyzed to gage their collective opinions about which technologies are the most suitable, and the strengths and drawbacks of those programs. It was found most scholars support using Geographic Information Systems (GIS), but many also advocate using flood simulation and remote sensing data processing programs. Many scholars also discussed the various limitations of using such technology. These programs can lead users to ignore important qualitative information, and difficult access to data hampers the effectiveness of these programs.

Secondly, the history of how the issue of flood protection has been approached in New Orleans was studied to see how the city has dealt with flooding before, and which residents benefitted the most from these efforts. It was found African-Americans have often been forced to live in the most at-risk neighborhoods, and have suffered the most as a result.

Thirdly, various natural and human characteristics about New Orleans were mapped using data from the United States Census Bureau, United States Geological Survey and Sewage and Water Board of New Orleans. These characteristics include the city's location, topography, African American neighborhoods, land uses, and the locations and quality of flood protection

infrastructure. This was done to learn which neighborhoods are the lowest-lying, who lives in those districts, the land uses of those neighborhoods, and the quality of those neighborhoods' flood protection infrastructure. It was found African-Americans still predominate the city's most at-risk neighborhoods, but the infrastructure protecting them has been improved since Hurricane Katrina.

It was found as useful as technology is in helping planners resolve the issue of how to best protect cities, using such technology has significant drawbacks. These findings were used to make multiple recommendations: improve public access to GIS and remote sensing data, keep such data up to date, install new flood simulation and remote sensing programs in government planning offices, and utilize other non-technological planning methods.

Introduction

The sight of dead bodies floating on the flooded streets of New Orleans after Hurricane Katrina pushed planners around the world to advance efforts to protect their cities against the ever-worsening effects of climate change. New Orleans is well-known worldwide for being highly susceptible to flooding. As the pace of climate change accelerates, major low-lying cities like New Orleans will become even more susceptible. Floods have consistently wreaked havoc on the city, most notably from destructive storms like Hurricane Katrina in 2005. Therefore, there is a pressing need for planners to figure how to better protect cities like New Orleans. In order to accomplish this, planners can use various technologies to help themselves devise solutions. But, they must remember using such technology has its drawbacks.

There are many important tools which planners have at their disposal to help protect their cities. Geographic Information Systems (GIS) is a powerful technology which allows planners to do many important tasks like creating maps which display crucial information about at-risk land and its residents. Since GIS and other related technologies will play such a crucial role in determining the best solutions for cities like New Orleans, it is important to analyze how GIS and other related applications can best be used to protect the city, and how these lessons can be applied to other cities. It is also important to understand the drawbacks of using such technologies, and what can be done to accommodate for this. Recommendations will be devised after first examining scholars' ideas about this, learning about the history of flood protection efforts in New Orleans, and mapping the city's natural and human profiles.

Literature Review

As the effects of climate change become more pronounced across the planet, many scholars agree cities will only become more vulnerable to such effects. Cities located in low-lying coastal areas are especially at risk, since they are prone to more severe storms and subsequent flooding. Many scholars are discussing the best tools planners can use to protect their cities from future floods. Scholars widely agree GIS is the most useful tool planners can use to prepapre cities for future flooding (Bathi and Das 2016, Baxter 2014, Brakenridge et al. 2013, Chung 2015, Driessen and Ledden 2013, Fussell, Curtis, and DeWaard 2014, Gerl, Bochow, and Kreibich 2014, Jonkman et al. 2013, Kashem, Wilson, and Zandt 2016, Miller, Jonkman, and Van Ledden 2015, Price and Vojinovic 2008, Williams and Ismail 2015).

However, some disagree as to which elements of the city planners should spend the most time on analyzing. Some emphasize prioritizing using GIS to map the natural aspects of urban environments (Chung 2015, Driessen and Ledden 2013, Gerl, Bochow, and Kreibich 2014, Jonkman et al. 2013, Miller, Jonkman, and Van Ledden 2015, Price and Vojinovic 2008, Williams and Ismail 2015, Brakenridge et al. 2013), while some emphasize mapping the socioeconomic characteristics of at-risk neighborhoods (Bathi and Das 2016, Baxter 2014, Fussell, Curtis, and DeWaard 2014, Kashem, Wilson, and Zandt 2016).

Many scholars disagree with this consensus. Some believe other technologies should be used instead of GIS. Some believe in using remote sensing data processing programs like Erdas Imagine (Brakenridge et al. 2013, Gerl, Bochow, and Kreibich 2014), some believe in using the Hazus-MH flood simulation application (Banks, Camp, and Abkowitz 2014), and some advocate for creating brand new applications (Liu 2015). There are even some who believe planners should avoid prioritizing the use of technology, and instead focus on directly working with

residents who live in at-risk neighborhoods (Douglas et al. 2012, Gotham and Campanella 2013, López-Marrero and Tschakert 2011).

Among those who support prioritizing the use of GIS, some argue the mapping of the natural aspects of urban environments using GIS should be prioritized. This involves mapping the topographic, ecological and geological characteristics of a city (Chung 2015, Driessen and Ledden 2013, Gerl, Bochow, and Kreibich 2014, Jonkman et al. 2013, Miller, Jonkman, and Van Ledden 2015, Price and Vojinovic 2008, Williams and Ismail 2015, Brakenridge et al. 2013). These experts argue this because they believe understanding cities' natural aspects is the best way to discover where floods can cause the most damge. As a result, those experts believe studying the socioeconomic characterists of people living in such areas should be done last (Brakenridge et al. 2013, Driessen and Ledden 2013, Gerl, Bochow, and Kreibich 2014, Jonkman et al. 2013, Miller, Jonkman, and Van Ledden 2015). Only some believe mapping the natural aspects of an urban environment should be of equal importance to mapping the human characteristics (Chung 2015, Price and Vojinovic 2008, Williams and Ismail 2015).

This disagreement among scholars highlights their differing beliefs regarding the planning process. This also reveals how the scholars' disciplines greatly influence their views of the planning process. Experts who come from more science-oriented disciplines will view the situation differently compared to social scientists.

Unlike some pro-GIS scholars who prioritze mapping cities' natural features, some emphasize the importance of using GIS to map cities' human profiles. This group of experts believes it is essentially impossible for a planner to fully understand how to protect a city from flooding without prioritizing the study of residents who live in at-risk districts. This can involve

mapping characteristics like residents' incomes and racial backgrounds (Bathi and Das 2016, Baxter 2014, Fussell, Curtis, and DeWaard 2014, Kashem, Wilson, and Zandt 2016).

Those who emphasize mapping cities' human profiles clearly come from the social sciences, where they frequently examine challenges through the human lens. It would be wise for planners to map both the natural and human aspects of any environment, as thoroughly examining both can lead to the better protection of cities.

Unlike the scholars who believe GIS should be used the most, some belive remote sensing data processing programs like Erdas Imagine should be used more. Remote sensing involves directing devices from a remote location to send signals down to a surface, and then collecting what gets sent back to the device. This can be especially useful for reading land elevation, as signals travel different distances from their devices to low and high land. These scholars point out how remote sensing allows for the cheap and practical conducting of land use surveys (Gerl, Bochow, and Kreibich 2014) and storm tide estimate surveys (Brakenridge et al. 2013). As a result, these technologies can eliminate the need to collect data through field visits (Brakenridge et al. 2013, Gerl, Bochow, and Kreibich 2014). These scholars argue using these techniques to spatially analyze cities can be more useful than simply relying on GIS, due to their findings which suggest many cities do not have have up to date remote sensing data. They also point out how without easily accessible and up to date data, it is harder to effectively use such techniques (Brakenridge et al. 2013, Gerl, Bochow, and Kreibich 2014).

Since urban planning is an inherently interdisciplinary field, it is important to listen to scholars from various fields when considering how to solve such issues. GIS has by now become a popular technology across many disciplines due to its myriad uses. Even though the benefits of using technologies like remote sensing ones are less known compared to GIS, remote sensing

programs should not be ignored by planners. However, they should remember these programs have their drawbacks. For example, without access to up to date data, it is difficult to effectively use any program.

There are also some who discuss the usefulness of using a computer program called Hazus-MH to better protect cities. Hazus-MH is a multifaceted computer program created by the Federal Emergency Management Agency (FEMA) which allows users to map hypothetical flood scenarios in any US community, analyze economic losses and estimate how many people who would be displaced. The scholars also point out how the program is affordable, simple to implement and straightforward to use, making it an ideal computer program for planners to use (Banks, Camp, and Abkowitz 2014). The scholars also mention how Hazus-MH not only incorporates GIS, but greatly expands on its capabilities (Banks, Camp, and Abkowitz 2014). This further proves how important it is to consider the ideas of experts from different disciplines, as scholars from different fields have been exposed to different technologies. These discussions regarding the advantages of using technology to protect cities show how many believe using such programs is the best way to create solutions which protect cities.

Many clearly advocate using pre-made computer applications to protect cities from flooding. However, some instead advocate creating completely new computer applications. Some scholars have gone ahead and created new programs which allow users to create their own three dimensional flood risk maps and access a database of maps made by other users (Liu 2015).

Some recognize the limits of GIS and other similar technologies. As a result, those scholars have created their own applications which build off the weaknesses of existing programs. This is important because this shows even though many scholars advocate using GIS

and other pre-made technologies, others have thoroughly analyzed the benefits and drawbacks of such programs and have decided to create their own applications. This also further shows the consenus among many scholars to prioritize using technology to protect cities.

Many clearly advocate for a heavily technological approach to this issue. However, some scholars argue the limitations of technology are so significant, the best method is to prioritize communicating with residents directly to understand what they believe should be done to protect their neighborhoods (Douglas et al. 2012, Gotham and Campanella 2013, López-Marrero and Tschakert 2011). To accomplish this, some scholars have led participatory activities in which residents sketched maps of their neighborhoods and highlighted locations they believed would cause the most harm to their homes if they become damaged by floods (Douglas et al. 2012, López-Marrero and Tschakert 2011). Other scholars focused on first researching themselves which neighborhoods were most in danger, then personally visiting those districts to interview residents about their successes and failures in alerting public officials about their flooding fears (Gotham and Campanella 2013).

These scholars contribute extremely important viewpoints because they show even though technology can be highly useful, such programs discourage their users from viewing issues from real human perspectives. As a result, these scholars prioritize learning about the human perspective. This group of scholars is clearly influenced by their social science backgrounds. They skillfully point out how pro-technology scholars risk not seeing the whole picture by focusing on using technology.

In conclusion, many scholars clearly advocate for using technologies like GIS, remote sensing, Hazus-MH and new applications to protect cities from floods. However, the experts who emphasize the use of technology disagree as to what it should be primarily used to analyze.

There are also others who understand the limits of relying too heavily on technology, and caution against using it as a result. These experts instead suggest prioritizing the analysis of how residents want to see their communities protected. Scholars agree even though GIS is highly useful in helping protect communities from future flooding, there are other useful methods, both technological and not, which can be used by planners to accomplish this goal.

Research Methods

In order to understand how GIS and other related programs can be used to better protect New Orleans from floods, information will first be collected about the previous methods the city has used to protect itself. This will create a better understanding of how the city has historically dealt with the problem. ArcGIS will then be used to create various maps of the city in order to demonstrate how such technology can help with protecting cities like New Orleans. These maps will show various natural and human aspects of the city. They will highlight the districts most susceptible to flooding and how the city has attempted to protect them. This process will also reveal if it is easy or not to access this data, and how this process can be improved.

Firstly, information will be collected about the history of flood protection efforts in New Orleans. This information will provide key insights as to what planners have previously done to lessen the impact of flooding in the city. This will help with understanding previously attempted solutions, and who has benefited the most and least from them. Various scholars' discussions about the benefits and drawbacks of such solutions will be analyzed. This will help with understanding what can be done differently in the future.

Secondly, data regarding the city's topography will be gathered from the United States Geological Survey and mapped. This elevation data will be displayed through contour lines. This information will be used to discover which districts are the lowest-lying and most naturally susceptible to floods.

Thirdly, if it is determined African Americans have historically been the city's most disadvantaged residents, data regarding which districts they tend to reside in will be gathered from the United States Census Bureau and mapped. It is important to know the locations of these

neighborhoods because this can prove whether or not these residents have historically been forced to live in New Orleans' most at-risk areas.

Fourthly, data regarding the city's land uses will be gathered from the United States Geological Survey and mapped. Analyzing where certain land uses are concentrated can show which neighborhoods can cause the most harm to the surrounding city if damaged by floods. This data will also give an idea of how many residents live in harm's way.

Lastly, data regarding the locations and quality of important flood prevention infrastructure will be gathered from the Sewerage and Water Board of New Orleans and mapped. It is important to understand which districts have the most up to date flood protection facilities like levees and pump stations, and if any neighborhoods lack proper infrastructure.

History of Flood Protection in New Orleans

New Orleans has long been known for being one of the most flood-prone cities in the United States. New Orleans will only become more susceptible to flooding as the effects of climate change worsen. To better understand how to best protect the city in the future, the protection methods New Orleans has previously tried must be analyzed to see what can be done differently in the future.

The most flood-prone districts of the city were often settled too fast for flood prevention infrastructure to be built there in time. The vast majority of New Orleans' flood protection infrastructure was not constructed until the 1920's (Baxter, 2014). This construction encouraged residents to move from the crowded city center to the newly habitable but low-lying outskirts. This movement was further encouraged by federal officials, who offered financial incentives to developers so they could build homes in those outskirts. Even though these neighborhoods became somewhat safer due to the construction of this infrastructure, the pace of construction could not keep up with the fast speed of the population expansion (Baxter, 2014). Due to this lack of proper oversight by authorities, many residents were clearly put in harm's way.

The speed of this expansion made planners prioritize the implementation of flood protection infrastructure in certain neighborhoods before others. Firstly, African American residents were often pushed to live in the lowest-lying neighborhoods, while whites often occupied the highest-lying districts (Baxter, 2014). Secondly, these predominantly white high-lying neighborhoods were given flood prevention infrastructure first before the low-lying African American districts (Baxter, 2014). This clearly shows how discrimination against African Americans by their predominantly white leaders has led to the situation in which New Orleans finds itself today. Racial discrimination has clearly influenced many aspects of the flood

protection process the city has taken. Planners worked to save white residents first before African American ones.

This discrimination against African American residents has led to serious consequences for them. Hurricane Katrina especially devastated poor black neighborhoods like the Lower Ninth Ward in eastern New Orleans. This is unlike the wealthier, higher-lying and more protected neighborhoods like the southwestern Garden District, Downtown and the French Quarter which all sustained minimal damage (Fussell et al., 2014). This further shows the inequality in flood protection between different neighborhoods. Residents have been consistently affected by government policies which prioritized the safety of some residents over others.

After Hurricane Katrina, New Orleans revamped its flood protection system to better protect residents of all socioeconomic backgrounds. Even though many residents' risks decreased after this, many are still at risk today (Miller et al., 2015). This proves how after Hurricane Katrina, planners did learn from the city's past mistakes. However, more work can be done to better protect all residents.

New Orleans has been hurt by floods throughout its history. As the effects of global warming worsen, the city will only become more and more vulnerable. In order to better protect the city, planners can use technology to figure how to best protect New Orleans. However, planners must also remember the drawbacks of using such technology.

Findings and Analysis

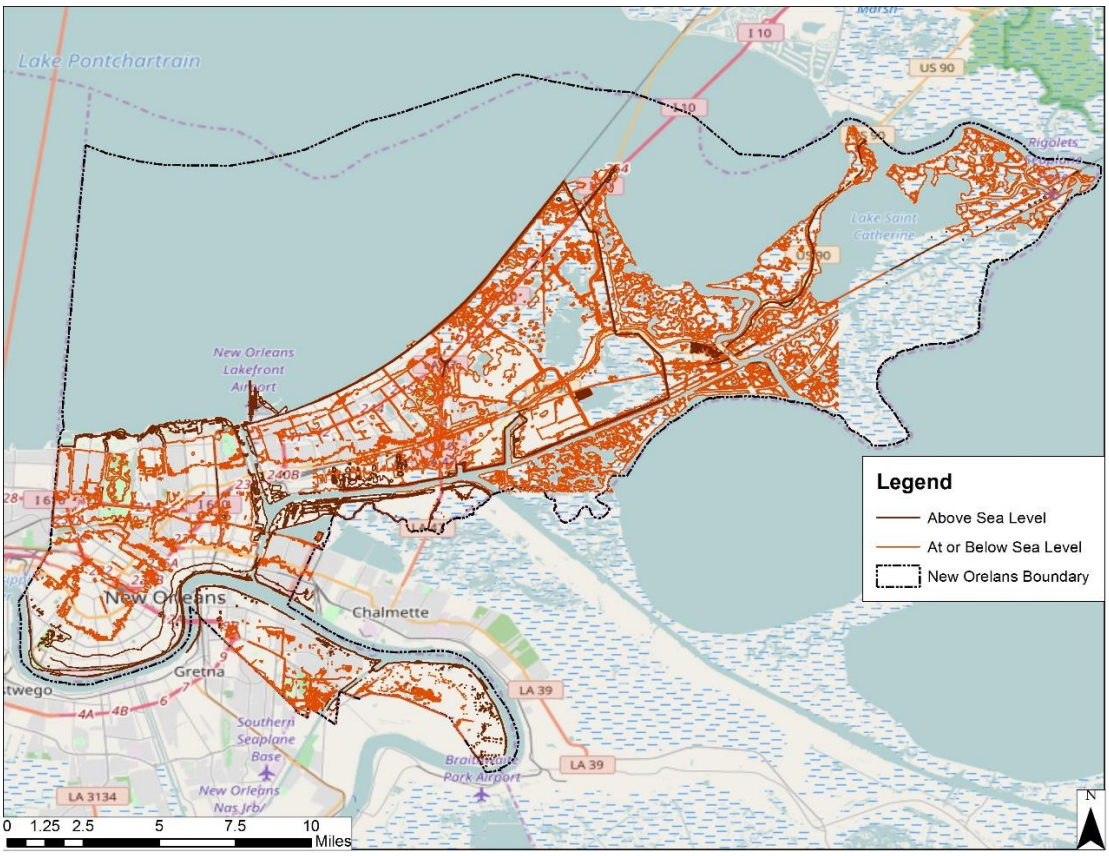
Figure 1. New Orleans Location Map

Data Source: U.S. Census Bureau; TIGER/Line Shapefiles, Figure 1, generated by Ian Schwarzenberg using TIGER/Line Shapefiles https://www.census.gov/geo/maps-data/data/tiger-line.html; (data retrieved on April 4th, 2017)

New Orleans lies just north of the Mississippi Delta, in the southernmost part of the U.S. state of Louisiana. It is also situated near other major water bodies like the Gulf of Mexico (Figure 1). The city's location near a major river delta is both a blessing and a curse. It is a blessing for the city economically, as it is situated directly on a historically important trade route. This has allowed for the city's economic and population growth. However, it is also a curse

because since river deltas are low-lying, the city will naturally be low-lying too. This makes the city naturally susceptible to flooding.

Figure 2. New Orleans Land Elevation Map

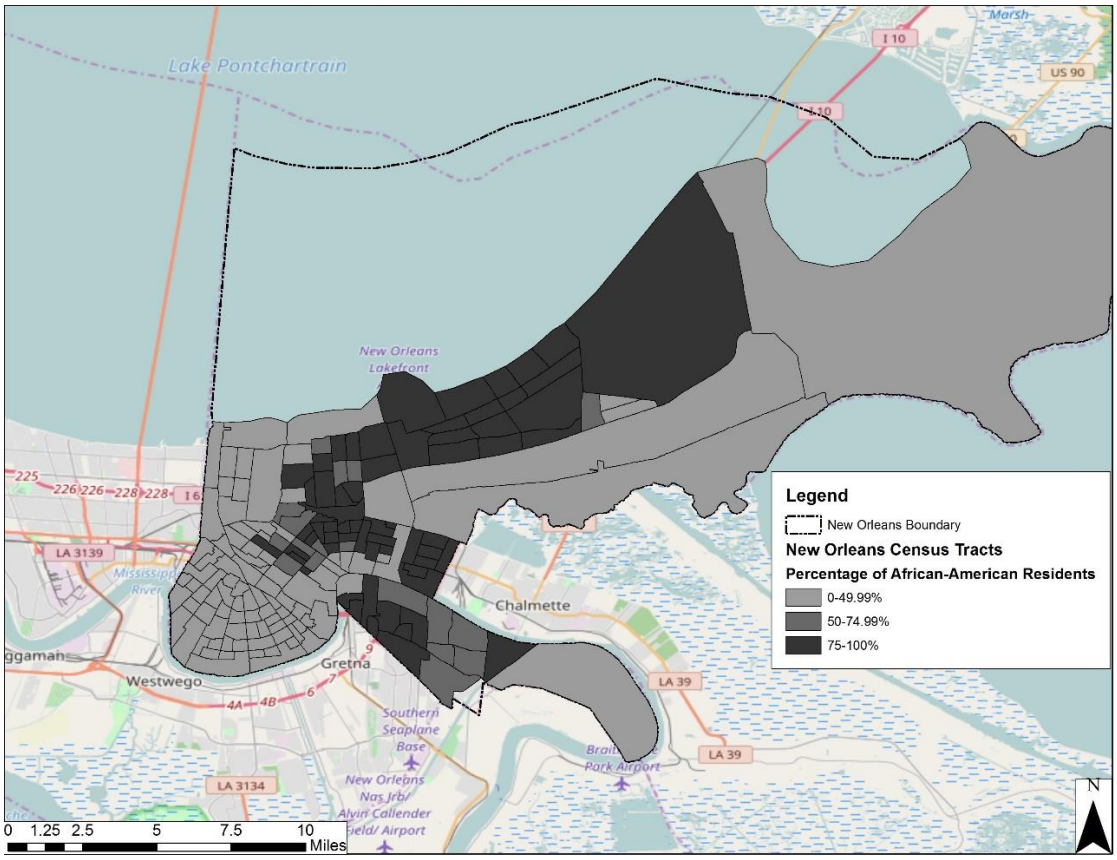


Data Source: U.S. Geological Survey; The National Map, Figure 2, generated by Ian Schwarzenberg using The National Map application https://nationalmap.gov; (data retrieved on March 28th, 2017)

The vast majority of the city is located either at or under sea level (Figure 2), highlighted in orange. Therefore, much of the city is naturally susceptible to flooding. The only parts of the city located above sea level are the extreme southwestern neighborhoods, Downtown, the French Quarter and the edges of its waterways (Figure 2), all of which are highlighted in red.

The high elevations at the waters' edges are likely levees. The land rises naturally in Downtown, the French Quarter and the extreme southwestern neighborhoods. This shows these three neighborhoods are on naturally higher ground compared to the rest of the city, and are therefore less susceptible to floods compared to the rest of New Orleans.

Figure 3. New Orleans African American Districts Map

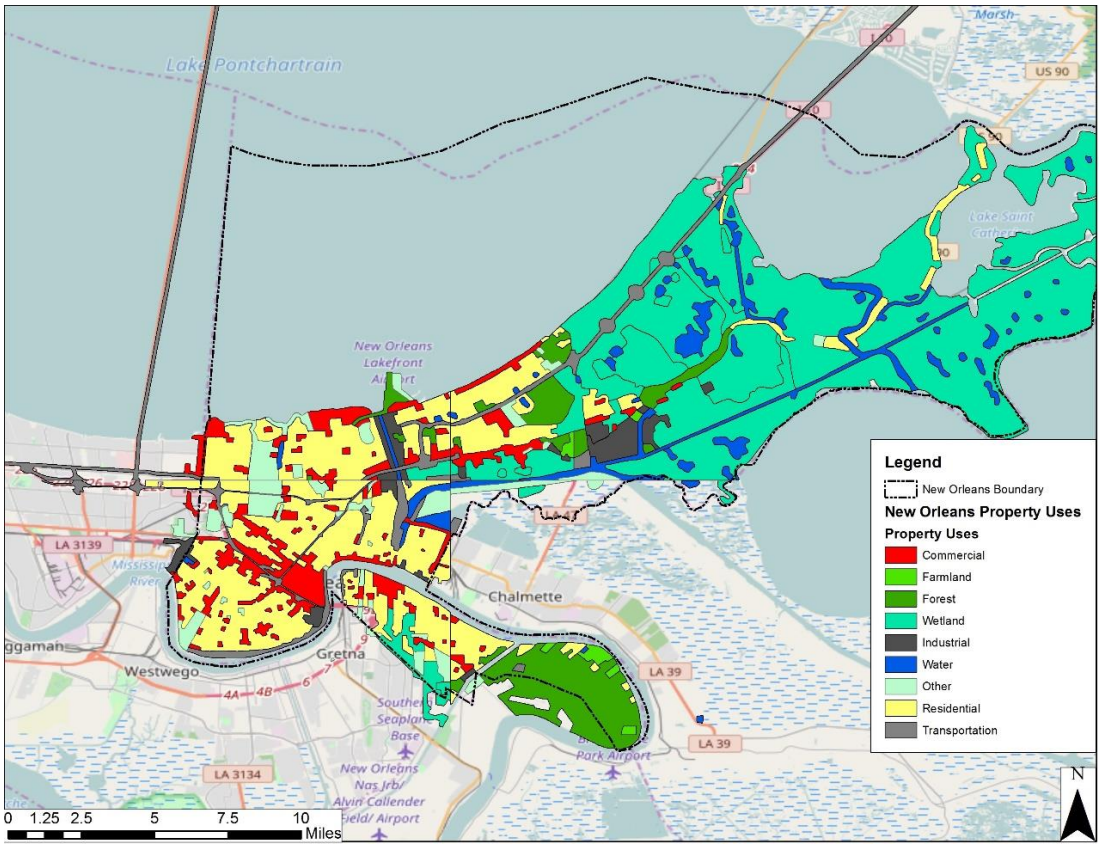


Data Source: U.S. Census Bureau; TIGER/Line Shapefiles, Figure 3, generated by Ian Schwarzenberg using TIGER/Line Shapefiles https://www.census.gov/geo/maps-data/data/tiger-line.html; (data retrieved on April 4th, 2017)

Even though African Americans make up much of the city's population, their white neighbors have discriminated against them throughout the city's history (Baxter, 2014). Much of

the city's African American population today lives in the northern, central and southeastern neighborhoods. They especially predominate the low-lying neighborhoods next to Lake Pontchartrain (Figure 3). This shows how the legacy of discrimination against African Americans in New Orleans is still visible today, as they still largely predominate the lowest-lying districts.

Figure 4. New Orleans Land Use Map



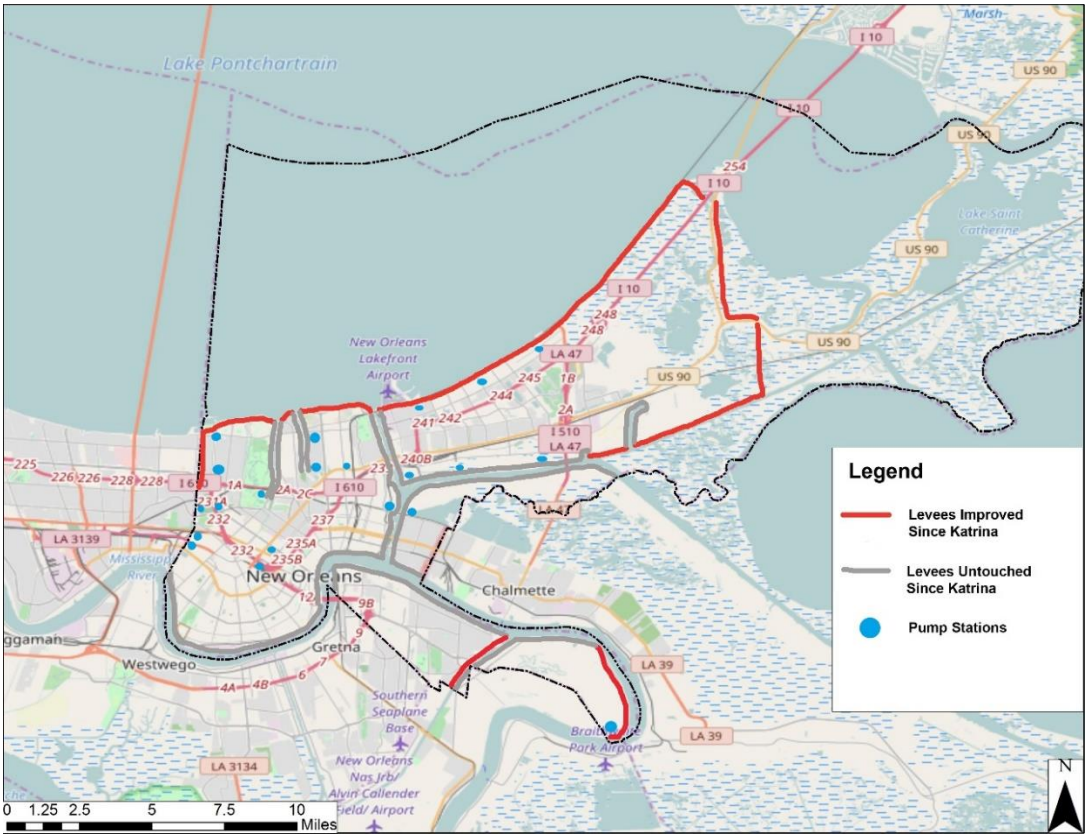
Data Source: U.S. Geological Survey; The National Map, Figure 4, generated by Ian Schwarzenberg using The National Map application https://nationalmap.gov; (data retrieved on March 28th, 2017)

New Orleans contains many different land uses. Many northeastern neighborhoods are dominated by wetlands, and large predominantly residential districts occupy the northern and

western portions of the city. Some of the highest-lying neighborhoods like Downtown and the French Quarter contain commercial structures, showing how planners placed the city's commercial center on the highest ground. The highest-lying neighborhoods are mostly dominated by commercial structures and the lowest-lying districts tend to be dominated by residences. However, there are some exceptions to this. For example, the high-lying southwest district is predominantly residential. There are also some important commercial strips located right along the shore of Lake Pontchartrain (Figure 4).

It is important to note how many residents live in the city's lowest-lying neighborhoods. This coincides with how African Americans have been forced to live in these districts. Since these neighborhoods are naturally more at risk for flooding, those residents are at risk. There are also some important commercial districts in these low-lying areas which are at risk. Damaging these commercial districts hurts the people living near them, because that is where residents can buy food, water and other necessary goods. Therefore, planners must consider these factors when planning how to best protect New Orleans.

Figure 5. New Orleans Flood Prevention Infrastructure Diagram



Data Source: Sewerage and Water Board of New Orleans (2015), Figure 5, generated by Ian Schwarzenberg.

Many of the city's northernmost and easternmost levees have been improved since Hurricane Katrina. On the other hand, there are many levees in the southern and central neighborhoods which have had little to no improvements since the storm. There are also various pump stations scattered throughout the city, mostly in the northern and western districts (Figure 5).

Planners likely decided to improve the levees in the northern districts first after the storm because those are some of the most vulnerable neighborhoods. They also likely decided to not

focus on the levees in the southern neighborhoods because those protect some of the highest lying neighborhoods.

It is smart for planners to allocate limited resources to the neighborhoods which need them the most. This shows how the most heavily African American neighborhoods of the city were clearly helped after Hurricane Katrina. This marks a break from the city's past, and it shows planners in New Orleans have learned from past mistakes. These findings suggest planners now focus on protecting all New Orleans residents, regardless of their racial and socioeconomic backgrounds. Due to the city's history of discrimination against African Americans, it is likely planners purposely kept the northern levees in worse shape than the southern ones before the storm. This is because the northern levees protected many African Americans and the southern levees protected many whites.

Lessons

Firstly, GIS was used to map all of these characteristics of New Orleans. This shows the importance of GIS for planners, since it helps them learn about crucial aspects of their environments. All of this helps planners improve those environments. These maps help planners understand which neighborhoods are most vulnerable, and the characteristics of those districts' residents. All of this helps officials decide which solutions are best and where to prioritize applying them to.

Secondly, other technologies besides GIS were involved in analyzing New Orleans. For example, the United States Geological Survey used remote sensing technologies to gather the contour elevation data used in the land elevation map. This shows how important it is for planners to look beyond GIS and consider using other related technologies.

Thirdly, it is clear these technologies would have not been effective without access to up to date data. The United States Census Bureau, United States Geological Survey and Sewerage and Water Board of New Orleans all provided reasonably easy access to their data. However, all those agencies spread out their data among various web pages, often complicating the process of finding it as a result. This shows how in order for planners to effectively protect cities like New Orleans, they will need to be able to easily access up to date data.

Recommendations and Next Steps

Planners are well suited to take advantage of the continuing technological revolution by using new programs which give them fresh insights into urban environments. Clearly, GIS is one of the most useful technologies planners can use to improve cities like New Orleans. However, all technologies have their limits. Planners must carefully consider the strengths and drawbacks of any program before deciding if and how to use it. Also, planners must have easy access to up to date data. Numerous recommendations can be drawn from this process for planners in all cities: improve public access to GIS and remote sensing data, keep that data up to date, and install new computer programs in planning offices.

Improve Public Access to Data

Planners can only do so much for their cities if they have limited access to GIS and remote sensing data. Making such data as easy to access as possible is important for two reasons. Firstly, the more information planners have to work with, the easier it will be for them to devise high-quality solutions for their cities.

Secondly, if members of the public have easy access to this data, they can use it to learn about their leaders' activities. This can potentially make them trust their leaders more, which makes it easier for planners to help residents as a result. This is because the more trusting residents are of their local governments, the more they will want to cooperate with them. In a city like New Orleans which has treated many of its residents unfairly in the past, making data more easily accessible to the public is crucial. For example, if the process of accessing the levee improvement data gets simplified, residents can easily learn how their leaders have worked to better protect them from floods. This can persuade those residents to trust their leaders more,

which will increase their cooperation with their elected officials. All of this will make it easier for planners to help those residents.

It is also important for these databases to be expertly organized so anyone can understand exactly where to find this data. Improving access to this data is useless if people cannot find the data they want due to organization issues. Planners must work to effectively organize all data to make it easily accessible to the public.

New Orleans has made strides with improving access to its data. Two of its websites, data.nola.gov and portal-nolagis.opendata.arcgis.com, provide access to important GIS data. However, much work needs to be done with improving those websites. They only provide basic information about the city, such as streets, crime incident locations, 311 complaint locations, and other similar information. Either of these sites can be improved by repurposing them to serve as sources for all GIS data about New Orleans. Such GIS data is currently spread out among numerous local, state and federal government websites. All data should ideally be compiled in one easily accessible website.

Keep Data Up to Date

It is also extremely important for cities to keep their data up to date. Many scholars have had trouble accessing up to date data for their projects (Brakenridge et al. 2013, Gerl, Bochow, and Kreibich 2014, Kashem, Wilson, and Zandt 2016, Price and Vojinovic 2008). In order for any government to provide the highest quality of service to its constituents, they must keep their data up to date. Having access to the most up to date data possible gives planners reliable information to base their solutions on. Relying on out of date data greatly hurts the quality of any proposal.

It was found the New Orleans government's data is mostly up to date. This is likely because city officials had to work hard after Hurricane Katrina to collect new data about the city to analyze damages. All cities can learn from New Orleans and other successful cities about how to keep data up to date.

Install New Technologies in Planning Offices

Finally, it is important for city governments to install the latest programs on their planning office computers so planners can take full advantage of those new technologies. City governments should especially install technologies other than GIS, since other programs have strengths GIS does not.

One of the most promising programs which planners in New Orleans can use is Hazus-MH. Hazus-MH allows users to simulate flood scenarios and damages caused by them. As of now, it is highly uncommon for planners who work for local governments to use it (Banks, Camp, and Abkowitz 2014). This program can be especially useful for planners in New Orleans, since Hazus-MH allows users to simulate potential flood scenarios there. It would be wise for the New Orleans government to not only install Hazus-MH on their computers, but to teach its planners how to use it. This way, those planners can effectively use the program to figure out how to best protect the city.

New Orleans and other cities can also install remote sensing data processing programs on their government office computers, such as Erdas Imagine. Doing this allows planners to more easily and effectively collect data about their cities (Brakenridge et al. 2013, Gerl, Bochow, and Kreibich 2014). Using programs like these is highly beneficial because such programs make it

easier for planners to cheaply and quickly collect the data necessary to improve their cities. This enables city governments to simultaneously keep their data up to date and save money.

Utilize Non-Technological Methods

While technology is helpful for protecting cities like New Orleans, technology simply cannot be relied on by itself. Planners must also use non-technological methods like engaging residents directly. Some scholars agree one of the biggest limitations of using technology is it encourages planners to ignore the human perspectives of the issues they are tackling (Douglas et al. 2012, Gotham and Campanella 2013, López-Marrero and Tschakert 2011). Technology can only go so far in helping planners protect cities like New Orleans, because directly communicating with residents can also give planners good ideas for solutions. Therefore, it is clear planners must not rely too heavily on technology to analyze their cities and devise solutions for them.

Conclusion

As the effects of climate change worsen, vulnerable cities like New Orleans must do all they can to protect themselves from future flooding. Floods have always wreaked havoc on the city and leaders there have worked to protect some residents more than others. Planners can use many new technologies to figure out how to best protect cities like New Orleans. However, these programs have limitations.

GIS is one of the most important technologies planners can use. GIS can enable them to create maps which display crucial information about the most at-risk land and residents who live on it. In addition to GIS, planners can use many other applications like Hazus-MH and Erdas Imagine, which help them even further analyze and improve their urban environments. These tools help planners devise even better solutions than they could before the advent of such technology. Much of these programs are user-friendly and cheap to implement. Therefore, it is wise for cities like New Orleans to install new flood simulation and remote sensing technologies in their offices so planners can take advantage of them.

Despite the many benefits of using such technology, they have important limitations. One limitation is poor access to up to date data hinders the effective use of such programs. Therefore, public access to up to date data must be improved so planners can easily find reliable information which helps them devise high-quality solutions. Members of the public will also benefit from this, as they can use this data to learn about how their leaders are improving their communities. Another limitation of technology is it can prevent planners from viewing the issues they are tackling from human perspectives. Therefore, planners must also focus on utilizing non-technological methods like direct community engagement when devising solutions.

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