Mapping Rhode Island Cemeteries in Flood Risk Zones

Senior Project Submitted to
The Division of Social Studies
of Bard College

by

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Dedication:

To My Sibling, to my Friends, to my Family, to my Teachers. You are all part of me.

Acknowledgements

Thank you very much to Charlotte Taylor, the Rhode Island Historical Cemetery Commission, the Rhode Island Historical Preservation & Heritage Commission, my advisor Jordan Ayala, and everyone who listened to me explain my maps.

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Note: Part of this project is also hosted on ArcGIS online as a story map. The URL is https://storymaps.arcgis.com/stories/e7554f47dd9048498beb62f663952f33
There will also be a direct link online.

Chapter 1: Introduction

I'm starting this thesis with two stories of cemeteries that were destroyed:

State Farm Cemetery Number 1 (CR060) had its first burial (marked by the Rhode Island Historical Cemetery Commission) in 1875. The cemetery was built to house those who died in Rhode Island's Alms House, and then later the State Hospital for Insane. Those staying there whose bodies were not claimed by their families (about a fourth of all who died) were buried here in paupers graves. Two coffins per burial, a small numbered concrete stone to point to an entry in the records. The cemetery itself was poorly kept, overgrown and with many of its stones damaged. At one point the whole site was clearcut, plowed, and mowed. The last burial was dated to 1917.[1]

You can no longer visit the cemetery. It's several feet under The Lincoln Ave Freeway (route 37), built in the 1940s. To this day there are 3066 people buried beneath a busy highway. People who must surely have suffered in life and deserve some dignity in death. This is not the end of the story. In 2006, heavy rain washed out a portion of the highway, exposing the coffins of 67 people, of whom only 59 could be identified. Those who were claimed by relatives were reburied elsewhere, but those remaining were interred at State Institution Cemetery #2. As of 2023, this new resting place is in a high risk flood zone, threatened by erosion from the Pawtuxet River.

[1] Rhode Island Historical Cemeteries Commission
http://rihistoriccemeteries.org/newsearchcemeterydetail.aspx?ceme_no=CR060

The Precious Blood Cemetery (WO006) is still a functioning cemetery today, holding over 16000 burials within its walls. While there is no note on the oldest stone in the lot, the most recent dates to 1993 (the year it was last surveyed). Right on the border between Rhode Island and Massachusetts, the cemetery today faces a small but significant vandalism problem but is otherwise well kept.

In 1955, hurricane Diane Hit Rhode Island. Built right next to Harris Pond, the Cemetery was at dire risk. The Horseshoe dam, built just to the south of the cemetery to keep Harris Pond controlled, was supposed to prevent or at least mitigate any catastrophe and to its credit the dam structure held. The Land around it however did not, and the flood waters ate into the hill that the cemetery was built on, washing out dozens of burials. Photos of these coffins floating along with flood waters paint a haunting picture of destruction and dismay.[2]

These two instances will not be isolated events. Already there are dozens of Cemeteries throughout the state that are within or near high flood risk zones and dozens more dotted along the coast. With continued effects of climate change such as more intense storms and sea level rise, many of these cemeteries will be either washed out or underwater. In any scenario this will leave countless families cut off from their ancestors, relatives, and families who have passed away, desecrating these most important sites. While large, actively managed cemeteries are already regulated and protected with an eye towards public health and safety, the many historical cemeteries

[2] Bonnie Phillips, “Historic Cemeteries Could See Grave Impacts of Climate Change in the Ocean State,” ecoRI News, October 3, 2022

1.1 The exposed ground beneath the Precious Blood Cemetery (Woonsocket Historic and Preservation Society)

that dot the state vary wildly in both size and active level of protection.[3] The RIHCC lists cemeteries in their database that vary from well kept family plots to massive unmarked potters fields to heavily damaged cemeteries right in the middle of urban areas. For many there is no formal ownership or management of the site, and many are either in the process of being lost to

[3] "Making the Connection to Cemeteries," Guides to Expanding Mitigation (FEMA, June 8, 2021)

nature or have already disappeared. These are important historical monuments, places of intense spiritual importance to tens of thousands, and they deserve to be protected.

FEMA lists several potential disasters that can all heavily impact cemeteries, but the one mentioned most and with the most dramatic effects is flooding. Flood waters can damage, destroy or move inscriptions, erode banks, flood tombs, and most notably wash away coffins and remains, scattering debris for miles downstream.[4] Historical cemeteries are especially at risk due to a range of factors. These cemeteries are often poorly documented, with many cemeteries containing unmarked or lost graves that may be damaged sooner than expected. With many, there is little to no funding present, given the orphaned nature of many cemeteries there are few organizations with the time and resources to protect every historical cemetery. Then there is the problem of regulations potentially reducing what is possible. Some defenses to natural disasters may harm or destroy the character of a historic place or sometimes the place itself if it must be moved. All of these make protecting historic cemeteries very difficult.

This thesis admittedly does not provide any solutions for the previously mentioned three problems. The only solution I can suggest is a lot more volunteering and money be invested in protecting our historical cemeteries. With the limited resources and time currently available however, strategy must be employed to protect those cemeteries that are most at risk. That is what I aim to solve. This thesis dives into the nuances of what is considered at risk, and through the use of the mapping and data analysis program ArcGIS I have created several maps and

[4] "Making the Connection to Cemeteries," Guides to Expanding Mitigation (FEMA, June 8, 2021)

displays that will aid in the allocation of funding and time. Through the course of the year I have been working with data from the RIHCC, FEMA, the US Census, and several other sources to identify cemeteries in high flood risk zones and zones of high social vulnerability so that when efforts are made to protect cemeteries from flooding and other environmental hazards those resources can best be targeted to do the most good.

As previously said, not all cemeteries are created equal, and while there are many cemeteries in flood risk zones, some do have established systems to protect them and mitigate risks. Others don't and likely won't in the future, especially in underserviced areas of the state .By using ArcGIS to map out cemeteries within the context of social vulnerability, looking at areas where there is likely to be less support from local and state governments, cemeteries that would otherwise be overlooked can still be protected. By putting the emphasis on cemeteries that already are unlikely to receive assistance or already have plans of protection in action we can push for these cemeteries to be more carefully scrutinized and protected.

This thesis at various points involved mapping out cemeteries, analysis of risk zones, and on the ground field work to confirm that the working theory held water. As a test for this method I put forward that it was a success, and that use of advanced mapping software is an invaluable tool for the protection of not just cemeteries but any historical or archaeological site in the face of climate change and ecological hazards.

Chapter 2: Theory

Before going into the reasons why cemeteries are worthy of our study and protection, there is one major question that should be answered: What is the purpose of a cemetery? The answer seems obvious: It is a place to put the dead. This seemingly simple answer does a lot to hide the full extent of the question. Why do we need to put the dead somewhere? This further question can be answered many different ways such as sanitation, land use, tradition, etc. but this utilitarian view quickly begins to lose legitimacy if it is thought about. If Sanitation or land use is the core problem, why are bodies not burned or dumped somewhere far away? Why is so much arable, buildable land instead turned over to the dead?

There is no one answer to the question due to the complex, varied, and multifaceted nature of cemeteries. Cemeteries are places that house, honor, and remember the dead buried there. Within these categories no two cultures or even no two cemeteries (shared culture or not) are exactly the same. However it is possible to look at cemeteries in general and deduce some general assumptions. Cemeteries provide a tangible connection to the history of the place they served, containing in each stone a record of those who lived and died there. Still operating cemeteries can provide a place of communal reverence and remembrance of the dead, creating a place within a city or town dedicated to these endeavors. Cemeteries also can be chilling reminders of the past toll of history, creating their own narratives within their physical organization that allow the past to be better understood and observed.

My hope here is to outline the various ways in which cemeteries can be understood through the lens of Anthropology and History, as well as how they can then be rhetorically used in the creation of said disciplines.

Cemeteries as Historical Texts

I may be stretching the definition of text here, but much like other historical texts such as personal accounts, histories, photographs, censuses, etc. cemeteries provide a direct account of those who lived and died in an area. At its most direct, stones and inscriptions provide dates of birth and death which can allow historians to track populations in an area, but far more can be recorded. Causes of death, epigraphs, and other pieces of information can be recorded about the person buried beneath the stone. Going even further looking at styles, imagery, or even how a cemetery is laid out can tell a trained eye a lot about the people who lived and died in the area but about whoever governed the management of the cemetery itself. A Catholic cemetery has distinct elements that separate it from an episcopalian cemetery or a jewish cemetery. This is all to say that cemeteries are yet another form of history making. While those who build, maintain, and use cemeteries may not think of them as such they remain as a testament to the many millions of people who came before us, lived where we do, and died. The act of preservation in this case is an act of history making, and like other forms of history making it is subject to the biases of both the natural world around it and the scholars and experts who continue its existence.

By History making I am using a definition borrowed from the works of Michel-Rolph Trouillot. History is broken into two main ideas: “True History” which is to say that which has happened (all of it down to the minutest of details and also as told from every possible perspective.) and history, that which can be recorded and is subsequently passed down, remembered, and taught. The difference between the two is obvious when they are contrasted thusly but the distinction is often forgotten or purposely left out. History that is created by historians and scholars can easily be presented as that true history which creates a major problem when the second main factor of Truillot’s writing is brought into focus. There is never just one history, but instead many thousands of histories, each with a different perspective on the “true history” that despite the physical impossibility of completeness is nonetheless a valid account. These various histories can of course be altered, hidden, or flat out fabricated, but the mere fact that one history differs from the other does not mean that one is the “correct” account. However a history and all that goes into it can be purposely expunged from public consciousness.

A history is not something that exists on its own. All histories in some way have an author who decided what evidence to use and how to present it. Because of this, at every step of the process the biases of the author can and do manifest no matter how hard they may try otherwise. The four processes that Truillot lists in history making are recording (those at the time of an event relating what they saw or experienced), archiving (the continued preservation of said accounts, whether physically, digitally, or orally), analysis (the work of the historian, looking through the archive and selecting which works the wish to pull from, and narrative construction (the final end product. The history that is created and how it is framed). Put like this it is obvious

how at every step perspectives and evidence can slip through the cracks or even be purposefully destroyed.

"Occurrences equally noted, and supposedly not yet subjected to interpretation in the most common sense of the word, exhibit in the historical corpus an unequal frequency of retrieval, unequal (factual) weight, indeed unequal degrees of factualness. Some facts are recalled more often than others; some strings of facts are recalled with more empirical richness than others even in play-by-play accounts."[5]

Often the voices and perspectives heard and recorded the least in history are those with little to no power, who either had no opportunity to record their stories or had such stories deemed less important (to archive, include, and teach). The biases of the historian directly shape how these aspects are written.

Time itself is also a factor in what histories are written down. It too acts as editor and often redactor. The vast majority of all perspectives, artifacts, and remains are lost to the slow churn of time. This is not to say that such losses are a natural occurrence. How a story is preserved can directly relate to how vulnerable it is to nature and time (perspectives left to rot in an abandoned archive are likely thought of as far less important than those kept in climate controlled storage facilities). This is part of the historian's job to attempt to suss out what other perspectives might have existed and to save those at risk of disappearing.

We can easily apply these principles to the cemetery if we stretch our definitions a bit. In a physical space the 4 processes still play out but instead of in print they are physical monuments

[5] Trouillot 1995, p53-54

on the earth. Pieces of history are recorded onto the stones themselves, marking each burial with some small snippet about the deceased. They are then preserved by whoever is in charge of the graveyard, acting as archivist for the dead and keeping a small record of history. This information in turn can be called upon by historians who desire a catalog of those who lived and died there, along with the specifics of the funerary practices around them. Immediately we can see how silences can occur within a cemetery.

Starting with recording, not everyone is able (or in some cases even allowed) to bury their dead with a marker. Potters fields where the poor and familyless were buried often have no stones whatsoever (as was the case in The Providence North Burial Ground (PV001) and other such cemeteries), or instead have numbered grave stones, each pointing to a reference somewhere in a state archive that may or may not have been preserved (such as State institution Cemetery number 2 (CR061) and other examples). Some people are simply not buried for a multitude of reasons. Cemetery records are (like all history) incomplete snapshots of past populations.

The problems inherent to archiving are again rather obvious when looking at physical places. Grave and the stones that mark them are constantly exposed to the elements, to vandals, and to other forms of degradation. A classic example of such destruction comes again from the Providence North Burial Ground (PV001). As the story goes, government officials who were seen as incompetent or otherwise in need of discipline were assigned as caretakers of the site, and as such many took their anger at such repositioning out on the stones they were tasked with

maintaining. Regardless of the truth there, it is undeniable that there are many stones with extensive damage from riding mowers within the site, some to the point of illegibility[6]. Such risk factors have to be mitigated and prevented, but these actions require money, labor, and time. Those in charge of maintenance and upkeep have to choose where to focus their efforts, and at every step the biases of those involved invisibly seep in. This is to say nothing of the hundreds of cemeteries that have no system of maintenance, either because they have been abandoned, destroyed, or lost.

While the two next processes (analysis and narrative construction) are definite factors, this project is focused specifically on the physical aspects of history, and thus while these may affect how resources are distributed in service of recording and archiving the dead they are less drastically impacted by changes in the landscape. Of course if a cemetery or grave is destroyed it can no longer impact the historical record, leaving a silence in its wake. The dead are a part of history, and gravestones do not just contain the raw information of who they were and when they died. Whole records of cultural change and remembrance and community are contained within cemeteries and their continued protection is vital. The selective nature of history in this way is one of the main reasons why we chose to focus on cemeteries in underprivileged areas. By doing so we wish to safeguard the historical narratives most at risk of falling through the cracks.

[6] http://rihistoriccemeteries.org/newsearchcemeterydetail.aspx?ceme_no=PV001

Cemeteries as Legacies of Oppression

Very little that is built by humans is positioned on the landscape at random. Whether it be for purely utilitarian purposes or some higher or esoteric goal, there are reasons why such structures are built where they are. With cemeteries there are some obvious concerns: building it in a place that is (relatively) accessible, a place[7] that is unlikely to be destroyed (through natural or human forces), somewhere where a grave can actually be dug, etc. There are numerous smaller, non-universal factors that may also come into play such as keeping a cemetery out of sight from or otherwise away from a population center or if land is scarce somewhere that is already unworkable for farming. Unfortunately the nature of archaeology is that a lot of the time we have to guess at what these factors were.

The lists above however are missing a large swath of potential influences, those being the more human, esoteric, or moral reasons for where to construct a cemetery. As previously stated there are observable signifiers within cemeteries that can inform a trained eye of the cultural background of those who are buried there, but even the placement can tell you something. In history, rarely is anything neutral, and in a country such as the United States with centuries of conflicting and clashing ideological sects and a history of racialized violence would come as no surprise that cemeteries and their locations exist in this framework.

[7] Place here refers to both a geographical location (where it is on a map) and a version of the place created by constant interaction between people involving or occurring at said place. Space is used interchangeably with Place.

A fantastic example of this sort of reasoning can be found in Leland Ferguson's Book *God's Fields*. The focus of Ferguson's research is on the historical town of Bethabara, located in northwestern North Carolina. Founded in 1753, the town and the land around it was owned and managed by the Moravian Church, an originally German protestant sect of Christianity that had originally made its way to the Americas in Pennsylvania. While the sect was originally emancipationist and radical for the time, the pressures of surrounding farmers, plantation owners, and communities slowly started to change the town to match. This was accelerated by the economic opportunism of using slave labor as opposed to hired Moravians to drastically cut costs and sustain a bigger population. Even after their emancipation little of the legacy was changed and Bethabara remained a segregated town.

Though segregation was an integral factor in how the town was laid out (such as how the original town was set up on a hill and what became the slave housing and then free black housing was a ways down from there) one of the places where it can be clearly seen is the two cemeteries within the town. The Moravians had a very specific structure of how to lay out these God's Fields or God's Acres as they were called (translating from the german) in accordance with their own ideology: separation between men and women, young and old, married and unmarried, and most importantly pious and impious. Strangers and converts were not buried in the main God's Acre (mostly, there are a few odd exceptions that Ferguson goes into), instead they were buried in the Stranger's God's Acre, located a ways to the north. Originally in the colony's history several black members of the congregation were buried in the God's Acre near the heart of town, but as the town became further segregated and a separate congregation and church was

established for the enslaved, what had been the Strangers God's Acre was converted to an all black cemetery. This was also because there was growing discomfort with the burial of white strangers and converts in the Strangers God's Acre, most of whom were moved. Thus two separate cemeteries existed within the town until some time in the late 1800s to early 1900s when the stones were removed from the site and hidden in the by then unused African Church building and the site was purposely forgotten.

The History of the Stranger's God's Acre and its Intentional Obliteration (as Furguson puts it) illuminate the problem of the selective process of history making that Trouillot described brilliantly. The legacy of segregation and slavery within a community who had originally preached against that is a part of the historical landscape, as is their attempt to hide it and its subsequent rediscovery. The Cemetery was destroyed and the stones hidden as a way to cover up the ugly side of history that the community did not want to face nor remember. This is almost certainly not a unique event. That is in part one of the problems with my method: there are many cemeteries, burials, or other places for the dead that are simply not marked. Either the history has been intentionally destroyed or no one has put in the work in the right archive to find them. Regardless, it is these orphaned and unknown cemeteries that are at an even greater risk than any identified by the work done here. But since they are practically invisible to us in the modern day, we cannot do anything, and instead we should focus on those cemeteries we know of that for one reason or another have been built in locations that put them directly at risk.

The example of the Stranger's God's Acre definitely focuses on the destructive aspect of these historical legacies, but that is not the only way that such events can shape the modern landscape. Furgeson gives greater context for why this cemetery was built where it is, not just why it was destroyed. As noted, the Stranger's God's Acre in Bethabara was built a ways to the north and down the hill from the main center of town, both seen as less desirable or spiritually lesser land by the Moravians. Thus is my central assumption: oppressed peoples and the cemeteries that serve them are given less importance and favor (both in terms of economic support and position in the landscape) when they are being constructed. That is not to say that they are given less thought. On the contrary as Furgeson points out the cemetery was not put there for no reason, but even so it was placed in a less favorable place before it was destroyed. The reasons behind this are multitude. Land that's more likely to flood or that is near an undesirable feature is cheaper to buy (such as State institution cemetery #2 (CR061), built right between a Landfill and the Pawtuxet River). Large cemeteries that have varying conditions likely make people pay for a premium for the better plots (such as up on a hill versus next to the river as is the case in The Providence North Burial Ground (PV001) where the potter's fields are both segregated and located in the north-western sections right by both the river and the highway).

The two examples I've listed are explicitly flooding related but that is not of course the only risk that cemeteries may face. Cemeteries are obviously not all built equally and for the same reasons, nor are their locations chosen at random. More generally this analysis of structures as they appear on the landscape can better illuminate why this protection work is crucial, and also why the focus on vulnerable populations is warranted. Location is not a neutral aspect.

Nothing is. The greater context of history weighs on these places and in turn affects how likely they are to be forgotten. The force of human will on the way history is shaped and remembered does not only extend out to those aspects that involve direct manipulation or destruction. Small, subtle influences can have catastrophic effects. In this case the ability for future scholars to know about who lived where and for future generations to find their ancestors is put in jeopardy because of the decisions of those who on every level affect how and why cemeteries remain.

Cemeteries as Living Places

The previous two methods of analysis both miss one key fact about cemeteries that again gives this whole project purpose: the people buried here are not the faceless spectors of history but ancestors, relatives, children. There is an innate humanity to the dead that should not go unmentioned. These are people who are in most cases still connected to living people, often people still living nearby. Cemeteries are places of genealogy, allowing for a greater connection across time. Again though this is incomplete. Looking at cemeteries from the perspective of an anthropologist and not a historian, cemeteries are also places of active life, not just death. They are public spaces for both grief and reverence. Cemeteries are not merely documentative; they are active places where connections with the dead are created and fostered.

This is not to say that genealogy or any other such information is unimportant. The Cemetery as a historical text is still a vital part of its importance and through the analysis of a cemetery looking through the lenses of methods one and two a lot of information can be gleaned about a space. This method goes further. There are reasons for preserving the actual physical space and not just a record of what once was. As stated before, cemeteries are utilized spaces for

the people whose relatives are buried there. This is why a simple record of a space isn't enough. Again, there are more reasons why one builds a cemetery beyond the purely utilitarian need to store the dead somewhere.

Cemeteries are not just places where a historical narrative is recorded, they are places where historical narratives are created and shaped by those interacting with them. Each stone acts as a monument to the life of the person who is buried beneath them, demanding that the viewer acknowledge the existence of this person's life. The cultural imagination around these stones continues the legacy of the person. This also plays into the way that cemeteries (as well as all monuments, for in a way cemeteries are a type of monument or monumental landscape) are continually used by future generations. By monument, I mean any physical construction designed for no function other than recording some deed or event and then demanding the attention of the viewer. That history etched into a monument may not be the "truth" of the matter (such as the monument in Fort Ninigret commemorating the "death" of the Narragansett Tribe despite their continued existence[8]) but the monument makes it tangible and thus dominates the greater perception of history. However that does not mean that they are permanent. Not only do perspectives shift as times change but monuments may receive supplemental interpretation or material (perhaps an explanatory plaque or some other addition) that redefines this history. Monuments are also not static and isolated from their surroundings. They are part of the landscape they inhabit and as such are influenced by the thoughts and activities of the people who live nearby and use the space. In the case of the cemetery this is much more limited than say

[8] Rubertone 2008, 195–216.

a public park or a roadside memorial. Cemeteries are places of remembrance and that is an active process.

This active process of remembrance is why the physical spaces must be preserved along with a simple record of the space and those buried there. This active remembrance is a critical piece of culture, especially in regards to the dead and we should not deny future generations of this activity. Cemeteries that are threatened, not just by flooding but by other disasters, construction, mere neglect threaten to break the generational connection of remembrance. As we've also seen, the people most at risk of losing these connections are those who already are at risk in general in society: minority racial and ethnic groups and low income families. Through this project, the hope is to alleviate this problem and create a tool to better see the scope of this problem. Already several examples have been mentioned where the effects of racism and discrimination had left and continue to leave those at risk in dire straits. Action must be taken.

Chapter 3: Methods

Taking this all into account, the task at hand demands attention, and in several cases the real life dangers will require immediate attention and action from regulatory bodies. The problem with this is that within Rhode Island alone there are 2895 sites recorded by the Rhode Island Historical Cemetery Commission. Granted, that number is inflated somewhat. Many entries within that set either point to a single site or are marked as no longer existing. But a site no longer existing or a site that has been moved does not mean that there is nothing there. Sites may still contain graves and burials even if any surface evidence is long gone. Regardless, there are far too many graveyards for one tired licenseless college student to visit, so we have to find a different solution for this problem.

Thankfully the RIHCC has done us all a great favor and mapped every single point, so we thus have a starting point for our analysis. This is where GIS as a tool is at its most powerful. While it is equally important for the creation of such maps, GIS's abilities to trivialize spatial analysis cuts what would otherwise be months of work by hand identifying and categorizing every single point.

In order to complete this project there were several main questions we had to answer. First: where are all the cemeteries located? This one is easily answered by the RIHCC, but there are alternative data sets out there that sometimes contradict each other. Second: How is risk defined? There are numerous ways of defining risk that again can contradict. Vandalism,

deterioration, and construction are all risk factors that I decided not to focus on. In this project I am mainly focusing on the threats of flooding, sea level rise, and erosion and their impacts on cemeteries in particular. This of course presupposes that no other factors influence risk. Third: Of those cemeteries at risk, how best do we further pair them down to find those most at risk and thus most in need of protection? Not all cemeteries are equally protectable or equally protected. Cemeteries in areas such as low income or majority minority neighborhoods may receive less protection from local and state agencies then those in wealthier, whiter neighborhoods[9]. The final question admittedly reveals the biggest flaw in this method: Is the data we have been analyzing and those cemeteries it has found to be at risk true? Through a combination of both human and machine error a lot of odd outliers may end up included in the data. This is part of why on the ground field exploration is so important (see chapter 4.5). A whole chapter is dedicated to answering this one question as best I can.

While there are doubtless countless examples of cemeteries in dire need located within rich white neighborhoods, the assumption we made while working on the project was that those examples are likely to be receiving protection already given extensive research on social group identity and built environment outcomes. This project is focused on the preservation of those monuments of history and community that are at most risk of disappearing. That being said, these same methods can easily be rescaled and tweaked to be more inclusive, allowing us to map these other points with little additional work. In fact both a general map of all cemeteries within

[9] See: Robert D Bullard, Dumping in Dixie : Race, Class and Environmental Quality (London: Routledge, 1990),
Patrick Sharkey, Stuck in Place : Urban Neighborhoods and the End of Progress toward Racial Equality (Chicago: The University Of Chicago Press, 2013),
Robert D. Bullard (1999) Dismantling Environmental Racism in the USA, Local Environment

flood risk zones and those specifically chosen as candidates for field exploration are included In chapter 4 and in the supplemental Story Map.

Question 1: Cemetery Data

For the project the main source of cemetery data I used was created by the Rhode Island Historical Cemetery Commission as previously mentioned who graciously sent it to me. Their website acts as an easy way to find specific graves and family members which when looking at the number of cemeteries is a huge and very welcome undertaking. Along with these records there is also documentation of the cemeteries themselves, listing the first and last dates of burial, the cemetery condition, and other useful information. Unfortunately this much larger data set was not available for download publically. The data I was able to procure was stripped of this in depth information (though each point did contain a link back to a corresponding and much more data-rich web page) containing cemetery codes, names, and Lat Long data. This was incredibly user friendly data and was easily loaded into ArcGIS for analysis.

There was one other data source I briefly experimented with before eventually discarding, that being a data set of cemeteries hosted by RIGIS. While it was useful to get a better perspective, I ultimately ended up discarding this data set in favor of the RIHCC data for several reasons. Firstly the RIGIS data was 11 years old. While this isn't as much of an issue for cemeteries as it would be for, say, a census where movement is constant (the dead don't get out much) 11 years is plenty of time for sites without proper maintenance to go missing. Secondly, the RIGIS data had 393 fewer locations than RIHCC. While this may have been a small problem of missing data, when looking at both sets of data on a map in ArcGIS there were numerous

points that did not line up between the two. This was mostly because of problem 3: precision. RIGIS only went to three decimal places of precision with its Lat and Long data as opposed to RIHCC's 6. This only worsens the previous problem. That being said, there are several points within the RIHCC cemetery data that do not match between the two data sets, even accounting for the precision problem. While both include a code for each cemetery they are stored in the data sheets differently and thus a one to one comparison is made much harder. While an interesting conundrum this aspect is best left to another project.

One final problem with the cemetery data was that unlike all the other data sets used in this project it was primarily point data. Instead of each cemetery being described by a polygon contorting to the actual physical area of the cemetery a single point is used to represent it. This provides a huge problem with false negatives. A cemetery may be in an incredibly high flood risk zone except for the one spot where its point says it is. At first a workaround was attempted using a Land Use and Land Cover map from RIGIS[10] but this only included cemeteries large enough (such as the Providence North Burial Ground or Swan Point Cemetery) to warrant their own land use zones. One other method tried that did not work was checking land permits to see if the cemeteries had their own unique plot numbers, but this too failed since many cemeteries are built on much large properties (such as the many cemeteries moved or destroyed by the Department of Transportation during the construction of the highways). Thus a buffer zone had to be constructed, extending out from the point equidistantly around it. For the majority of the project a 100 meter radius buffer was used, supplemented with the Land cover use where it

[10] Rhode Island Historical Cemeteries Commission
https://www.rigis.org/datasets/edc::land-use-and-land-cover-2011/about

applied. While admittedly quite large, the logic behind this choice was that it would allow for a greater visualization of the area around the cemeteries (thus alerting us to risks that would otherwise be missed with a tighter radius). Later in the project the method was changed to directly measuring distances between points, and then categorizing each point into bins of 100 meters, 50 meters, 20 meters, and 5 meters, thus allowing for more fine grained analysis while initial measurements were taken using all points within 100 meters. Any cemetery that would be within a flood zone would almost certainly be marked and further more specific analysis could easily be done.

Question 2: Defining Risk

As previously mentioned, there are a whole host of factors that affect cemeteries, both natural and man made. While abandonment, lack of maintenance, vandalism, and other risk factors are certainly important and would be worth analyzing, this project is mainly focused on risk factors caused by extreme or abnormal weather and climate conditions. With global warming and the slow but ever present threat of sea level rise and weather pattern change these risk factors are an immutable threat to the coastal and relatively flat state of Rhode Island. The main three factors looked at in this project are Flooding, Erosion, and sea level rise, but all three of these factors are interlinked. Areas with a high risk of coastal flooding are also in imminent danger from sea level rise, and flooding can speed up the effects of erosion. Thus for this project the main point of analysis has been using flood risk factors and then extending that out to include other factors, assuming the correlation.

The core of this analysis was done using The Flood Hazard Areas map created by URI Environmental Data Center and RIGIS[11]. This is an incredibly dense and feature rich dataset, but for our purposes the most important aspect was the section outlining specific flood risk zones in 4 different categories: Areas of minimal flood risk, areas protected or partially protected by levees, areas with a .2% annual risk of flooding, areas with a 1% annual risk of flooding, and active floodways. The data itself is collected from Flood insurance rate maps collected on the county level. While the assumption we made is that these flood insurance rate maps are accurate, there is always the possibility that the data is skewed by this focus on insurance, thus resulting in underserved or undervalued areas, but since the data we were actually using is about the actual flood risks and not a monetary analysis this should have little impact on the actual analysis.

For the initial analysis one further metric was used to pare down the number of at risk cemeteries to hopefully find those at most risk. FEMA's National Risk Index (specifically at the census block group level[12]) was used to find the communities that would be most affected by national disasters (in our case riverine flooding, coastal flooding, and landslides since those three are the most relevant to our analysis). The Nation Risk Index does start to move towards question three since its calculations are done by multiplying the expected annual loss for a Block Group (how much money in personal and property damage is expected for a given disaster)

[11] https://www.rigis.org/datasets/edc::flood-hazard-areas/about
[12] The smallest geographic area that the United States Census publishes sample data from (where not all households are included

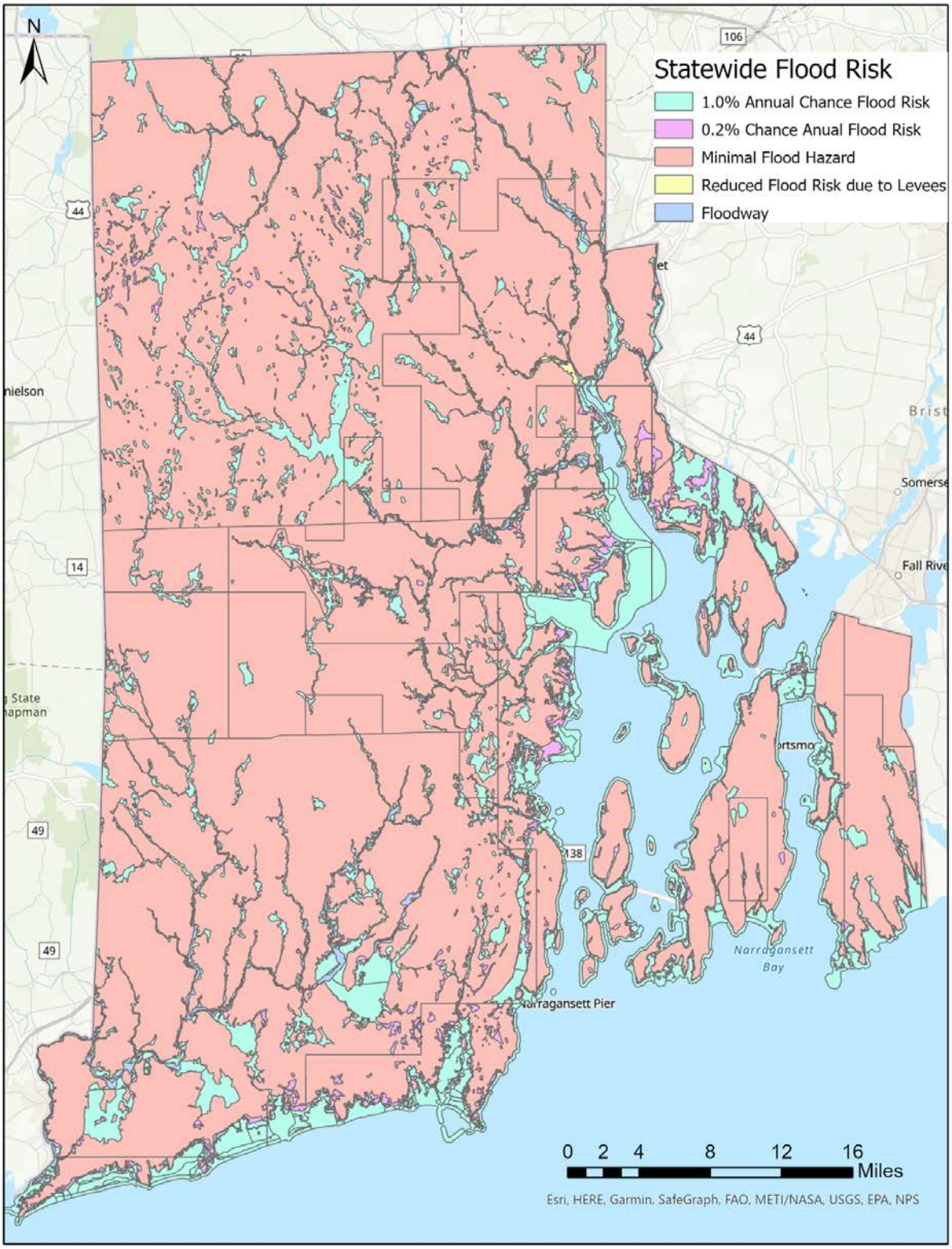


Fig. 3.1: Map of Rhode Island Data sourced from RIGIS

multiplied by the social vulnerability of the area. Thus while it does allow us to see where these disaster risks are it slightly obscures future analysis. For our purposes, block groups with greater than median risk factors for coastal and riverine flooding were used. In hindsight this step was likely redundant but it did mean there were fewer cemeteries to consider when selecting good candidates for field reports.

Question 3: Social Factors

While analyzing pure environmental risk is certainly useful it isn't and cannot be the whole story. Different areas react differently to the same storm and different areas are less able to prepare, react, and rebuild. In risk analysis the human aspect (and often on top of that the governmental or bureaucratic aspect) must be considered. In our analysis the assumption made was that cemeteries located within underserved areas would be more at risk due to a well-documented lack of funding, governmental interest, or political drive to protect them.[13] Our hope in highlighting those cemeteries that would receive little municipal assistance is to better direct hypothetical statewide or federal funding to those sites least likely to be protected on the town or county level.

This assumption also assumes that the people buried at a particular place have no bearing on how the cemetery would be protected in the modern day. Many of the cemeteries within Rhode island (and in fact many that we looked at in person) were built at least two hundred years

[13] See: Robert D Bullard, Dumping in Dixie : Race, Class and Environmental Quality (London: Routledge, 1990),
Patrick Sharkey, Stuck in Place : Urban Neighborhoods and the End of Progress toward Racial Equality (Chicago: The University Of Chicago Press, 2013),
Robert D. Bullard (1999) Dismantling Environmental Racism in the USA, Local Environment

ago. The populations that build them and were subsequently buried there have very little correlation with who is buried there now in many such cases. Our assumption is that this disconnect matters less than their physical location. Regardless of who is buried there, the ability for the local municipality to have the capabilities of doing anything is a much more pressing issue. We can't rely on absurdly wealthy next of kin to save every cemetery.

Several risk factors were considered, but in the end we settled on two: percent low/moderate income residence and percent minority. Data for each was pulled from the United States Census (again at the Census Block Group level). In order to filter out those communities that weren't of interest a decision had to be made as to where to draw the line. We ended up looking at all census tracts with higher than median percent population of each group. While the income dataset already included values as percentages the dataset for Race did not, so that had to be calculated. In the end 392 of 789 census tracts were identified with above median percent Minority (roughly 19.3% which is admittedly small) and 394 of 789 census tracts were identified with above median percent low or moderate income (roughly 39.2%). Of those there were 366 with both.

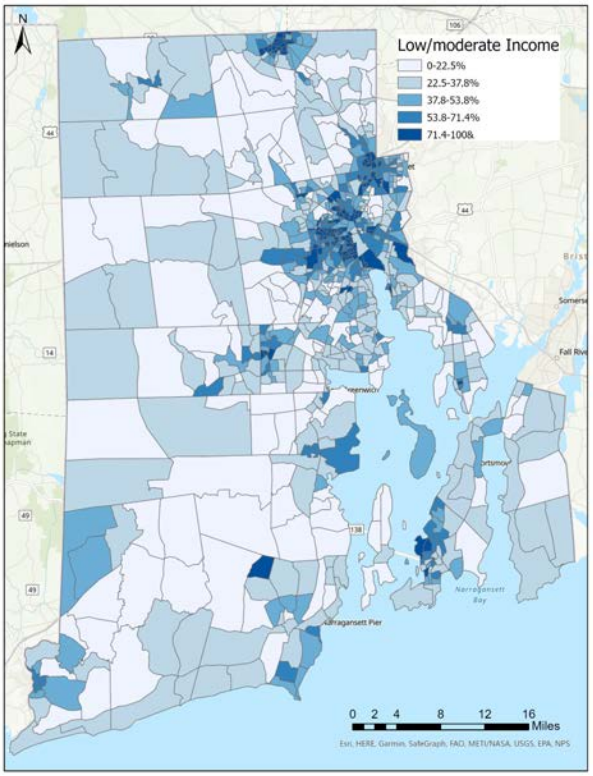


Fig. 3.2

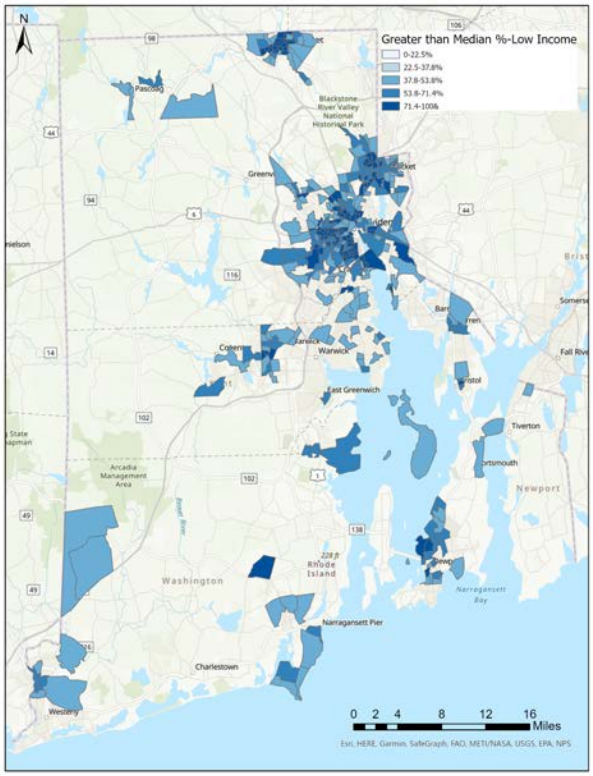
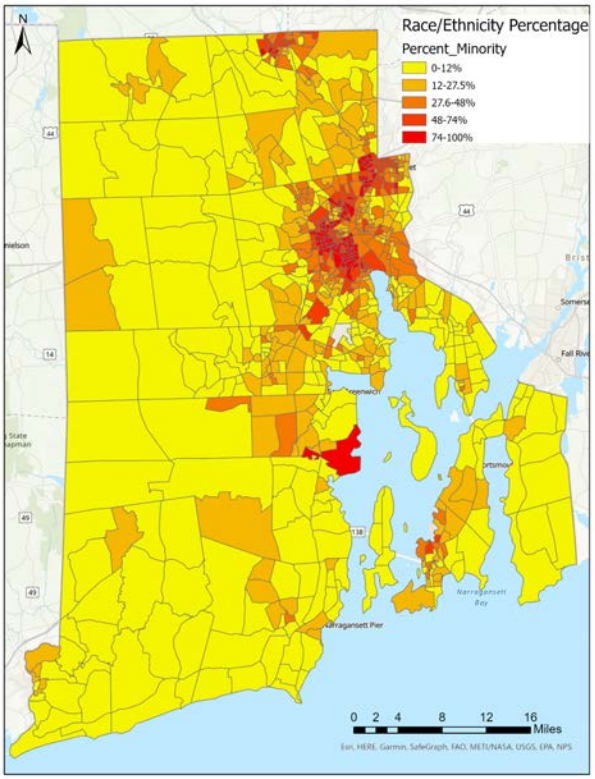


Fig. 3.3



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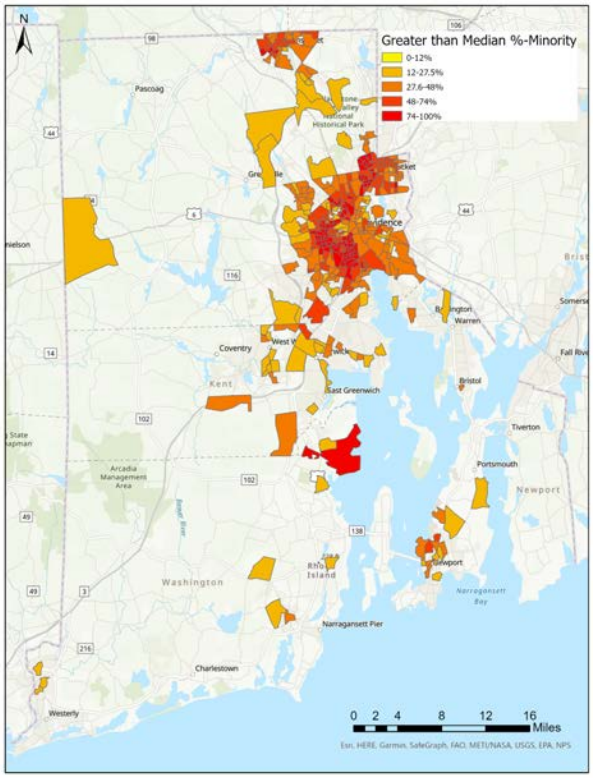

Fig. 3.5

Chapter 3.5: Problems with the Method

While all of these factors do provide a stable foundation for future analysis, there are of course numerous small and often compounding problems that crop up when working with data on a scale as large as this. One of the core assumptions one has to make when working with data is that it is at least on some level accurate to the real world. This is a dangerous but necessary assumption to make, but there are always methods to mitigate the effects of bad data. At the heart of it though is the old computer science mantra "bad data in, bad data out." While steps such as ensuring the correct world projections, double checking calculations, and keeping records of work are important there are several aspects that don't have simple intuitive solutions.

Problem 1: The Modifiable Areal Unit Problem

This is the bane of many data engineers. The core of this problem is that at some point in data analysis there has to be some sorting of data into larger sets. This could be because of privacy concerns such as a census, it could be because the data itself was taken with an imprecise or wild lens, or a host of other problems. Even with the finest most precise form of data taking this problem cannot be avoided, only minimized. Eventually if you zoom in far enough you will find a feature or data point that straddles the line between two areas. Borders are not the only problem areas. By drawing many different definitions in a set of data you can manufacture dramatically different results just by reordering groupings.

In terms of the project itself this was part of the reason why buffer zones and not individual points were used to represent cemeteries. By getting a wider look at the area around

the point as well as taking multiple different sized radii around each point (hopefully) allows for a better understanding at a glance. Thus the problem of points straddling the lines or being just outside of flood zones is hopefully caught. The other way to mitigate this problem is to work with the finest, most precise data you can get your hands on, but with data from the census and from FEMA the most precise they had available was by the Census Block Group level. While these areas are usually small enough not to have any major problems there were several anomalies in the data that ended up with several cemeteries wrongly flagged as in high social risk zones (I go more in depth in chapter 5).

Problem 2: Double Dipping

A bit less technical than the previous problem, double dipping is when a data set or analysis is run multiple times, thus resulting in a much sparser selection at the end of the process then what may be needed. This is a somewhat antithetical problem to the Modifiable Areal unit problem because instead of stemming from a lack of focus this problem is the result of too much focus. Without a wide enough scope there may be countless points that would be lost that need the help. Especially when running multiple analyses on data that each do their own (possibly redundant) task at some point one has to step back and figure out what is actually necessary.

The solution to this problem is of course to take a wider sample of data, but this can run up against the modifiable areal unit problem. To fix one increases the power of the other. A medium value between could possibly be solved, but it is also possible that both work in tandem to ruin a dataset. The world is very complicated, very detailed, and very hard to break up into sections.

The Solution: Field Inspection

The main factor that these and most other data analysis problems share is that they are caused by attempting to fit the world which is very large, messy, and without obvious natural dillineations, into a form that can be easily analyzed, whether by human or machine. As much as flood risk zones or census tracts or any other form of categorisation can tell us about the world, they can only provide a rough outline of the real world situation. The data we have been using and analyzing presupposes that, for example, everywhere in a high flood risk zone is at equal risk and no other factors influence how likely a certain property might be inundated or washed out. This is simply not true, but the only way to find this out is to go out into the field and look for ourselves.

The whole process of finding those cemeteries most at risk was certainly in part to help with the long term strategy of protecting at risk sites, but in the short term it also gave us a manageable list of potential candidates that we could visit and observe. While the hope of the on the ground inspection was to find some cemeteries that were at dramatically high risk so that any local authorities could be notified, it was also the perfect way to test if the previously outlined methods could actually find all the cemeteries that were most at risk. Thus over the spring of 2023 I conducted several field surveys of graveyards flagged by these maps as high risk both to test its effectiveness and to get a better understanding of the problem at hand. Some cemeteries were unfortunately left out. Time for field studies was limited and some were simply inaccessible to the public. But The surveys included in chapter 4.5 should hopefully highlight both the triumphs and failures of this system.

Chapter 4: Initial Results

First to report are the results of flood zone risk assessments (see Figures 3.1 and 4.1). Of the 2,886 cemeteries (both currently existing and lost/moved) listed by the RIHCC, 279 are within between 100 meters and 50 meters (colored green), 178 are within between 50 meters and 20 meters (colored yellow), 73 were within between 20 and 5 meters (colored orange) and 119 were within 5 meters (colored red). 98 listed cemeteries were directly within marked flood zones. While these cemeteries most at risk appear fairly evenly distributed along both the coast and near rivers and lakes there are some hot spots. Barrington, Wickford, and Warwick each have their own clusters which makes sense given that they are all coastal and are only just above sea level.

Further reducing the scope, we can now bring in the race and income data to get a more manageable set of points to investigate on foot. Within Census Block Groups found to contain higher than median percent minorities or Income there were 579 cemeteries. Of those 73 were within 100 meters, 43 were within 50 meters, 15 were within 20 meters, and 38 were within 5 meters (leaving 410 marked as not near a flood zone). Of the 38 within 5 meters almost all of them (32) were within flood zones.

While this is a fantastic starting point, it is of course imperfect. Looking over the data there are several points that should probably not have been included that due to the nature of census block groups were still labeled. The Town of Wickford is a good example, with the town itself being one of the most expensive areas in Rhode Island and yet still being counted as within

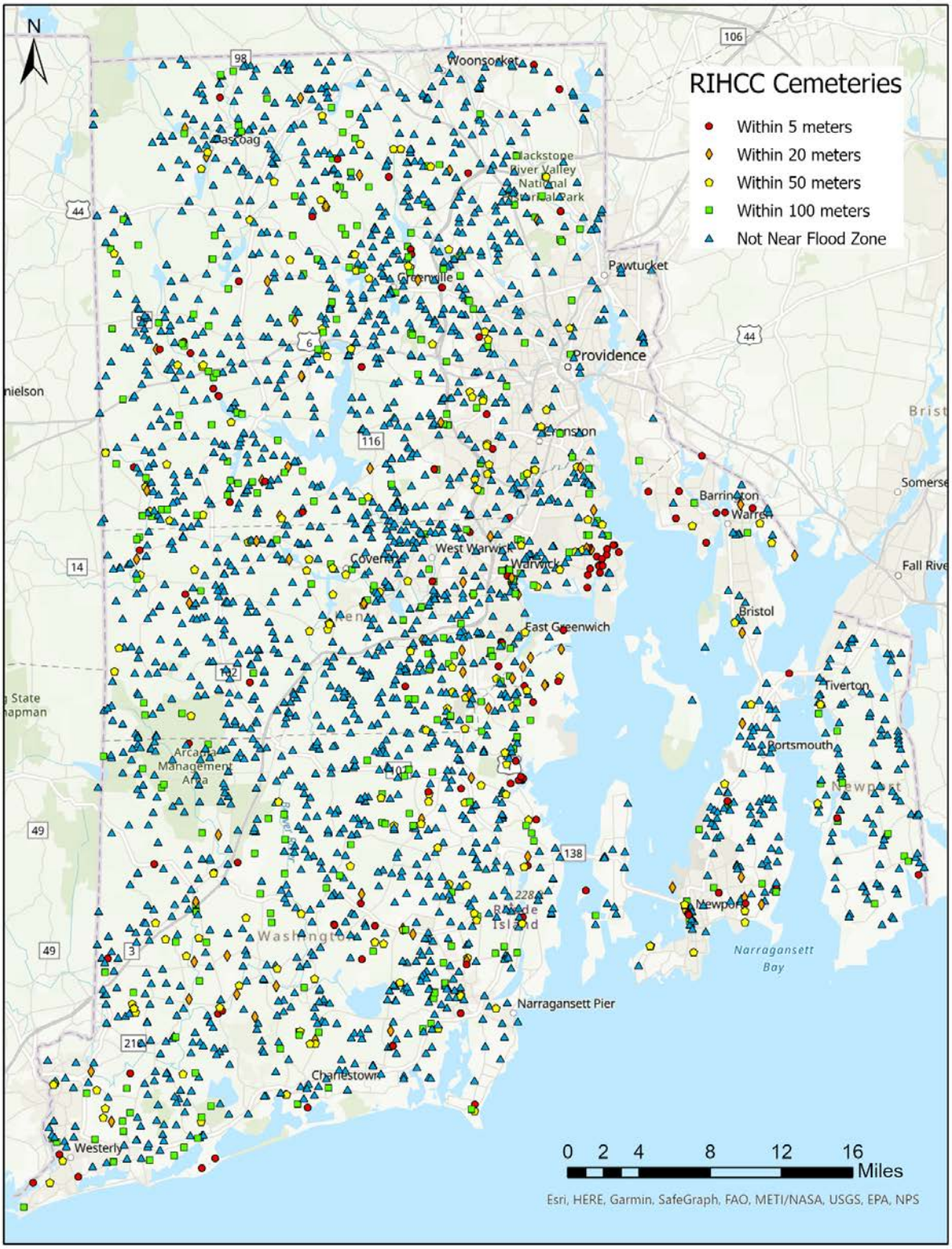

Figure 4.1: A Map of all Cemeteries listed by RIHCC (an interactable version is also available)

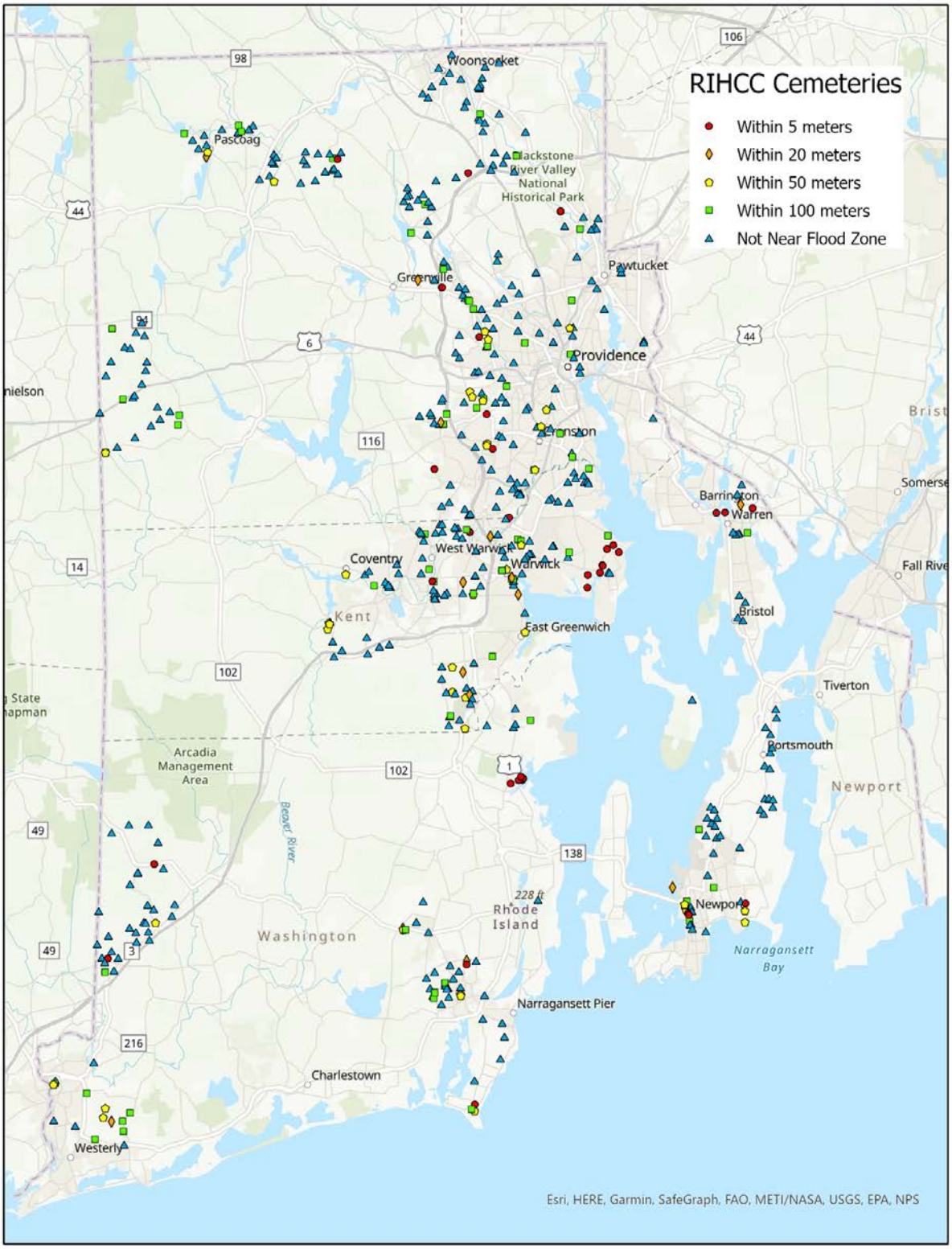

Figure 4.2: A Map of all Cemeteries listed by RIHCC that are also within High Risk Census Block Groups

one of our target block groups. My guess is that there is a substantial number of minority residents outside of the town borders but still within

the area of the block group. (to see more see the report on sites NK093, NK062, and NK044). There are also numerous factors that this data cannot catch. Erosion is not just a function of rivers. Among risk factors listed by FEMA for cemeteries specifically, other criteria include easy access, steep slopes, and of course the human and monetary resources needed for upkeep and restoration in the event of such a disaster.

This thesis will not be able to tackle these issues, but hopefully ArcGIS will be a powerful tool in the future for analyzing these other aspects. Byond this, these are mere models and representations of the real world. What does “within a flood zone” actually mean when you’re on the ground? As mentioned before two cemeteries that are both within flood zones might have radically different maintenance levels, drainage systems, soil makeup, and dozens of other factors that may determine which survive the next Hurricane Diane.

This is the main reason why on the ground reports are so important. The cemeteries listed are hopefully a good sample of various different conditions, risk factors, and other considerations.

Chapter 4.5: Cemetery Field Reports

Before we get two into the weeds with specific examples I want to clearly outline what would be seen as a "risk factor" out in the field as opposed to in the digital map. As mentioned in chapter 3.5 their nuances of the real world are often lost in simulation, so attention has to be put back onto these factors. There were several key elements that we were specifically looking for that signaled to us that a particular cemetery was at risk or not. Those were:

Erosion: Plain and simple, we were looking for any signs that the ground around the cemetery was being shifted. This could be the formation of gullies, banks or ridges being carved, or a multitude of other factors. The closer this erosion was to actual graves the higher the risk.

Inundation: If there was a flood, would flood waters pool in the location? While this aspect was something we were kept to take into consideration, in the grand scheme of things this seems like less of a pressing risk than any of the other categories. We included it regardless because it could still be a sign of other factors we wouldn't be able to see just looking at the surface.

Coastal placement: This was mostly taken into consideration when threats such as storm surge or sea level rise were the most pressing. If a wave of water was going to hit the cemetery in question, where would it do that and what would be there? This can fall under the threat of erosion, but it's not always obvious.

Height: how much does sea level have to rise before the cemetery is inaccessible. In many coastal cases the answer was "not much".

All Cemeteries were selected from those within 100 meters of flood zones.

WR003 (Kickemuit Cemetery)

(Within 0m of a flood zone) This cemetery was the first we went to and by far the most at risk. WR003 is located at Lat 41.738071 Long-71.262024 in the town of Warren, along Serpentine road (no number, but across the street from #63). It contains 400 burials within four sections, with the oldest dating to 1697 and the newest to 1898. It is separated from the road by a stone wall, but on the side facing the water there is little protection. The graveyard is built up against the Kickamuit river where it begins to mix with the Narragansett bay.

Fig. 4.5.1 Kickemuit Cemetery facing south. Only Half the Cemetery is in frame.

We were lucky enough to arrive when it was low tide and the bank was exposed. The riverbank has an overhang of several inches, held together by tree roots. In several spots there were small gullies forming. While for the most part there was still a few feet of space between the bank and any graves, the consensus between surveyors was that if one of the many large trees came down in a storm it would take several graves with it.

Fig. 4.5.2 The riverbank below the cemetery showing signs of erosion

We were going to give it a rank of three (active erosion present) and leave it there, but then the situation became much more dire when we found several graves less than two feet away from the eroding bank. Looking at the whole of the cemetery, the southernmost tip would be right in the path of a storm surge. With a big enough storm the whole bank could be washed out, taking several graves with it. Unlike the rest of the bank and graves that would be at risk within the next few years, it is possible that these graves on the southmost bank could be gone within the year. Overall this yard gets a 4. Several marked burials are directly at risk, and there may be several more at equal risk that we didn't see, since a fourth of the burials there do not have stones.


Fig. 4.5.3 Headstones Dangerously close to the water

WR014 (Obadiah Bowen Lot)

(Within 8.1m of a flood zone) On the other end of the spectrum from WR003 is the Obadiah Bowen Lot. located at Lat 41.740261, Long-71.271692 behind the parking lot for 317 Market St, this cemetery is located on a small rise overlooking a wooded swamp. There are 80 known burials here, with the oldest dating to 1697 and the most recent to 1897. Most if not all appear to be marked with stones. The lot itself is about three feet above the parking lot it connects to, and slopes downward to the south west, with the lowest point less than a foot above water, with a small stone wall separating it from the rest of the woods.

While the lot is on a not insignificant slope, there were no obvious vectors for erosion besides rainfall. The burials we could see were all clustered together in the north eastern corner (the highest point) extending towards the middle of the lot. While the eastern edge of the lot could certainly be flooded and inundated with water, there didn't appear to be any risk associated with that. Overall while this cemetery may be one to keep an eye on, there is no immediate risk posed.


Fig. 4.5.4 The Cemetery, taken facing South-east

WR001 (Warren North Burial Ground)

(Within 0m of a flood zone) A fairly large cemetery in the heart of Warren, built next to the Saint Alexander Catholic Church. It is located at Lat 41.735431, Long-71.284297. Within are 1500 listed burials, 925 of which have inscriptions of some kind. The space is large and well managed with an iron fence surrounding all sides and is a good distance (500 feet give or take a few) from the nearest body of water.


Fig. 4.5.5 The Burial Ground, Taken facing North

This is one of the first cemeteries we visited where the current situation it is in does not require management, but rather soon the whole cemetery will have to be moved. In terms of flooding there is definite risk. The whole of Warren is only a few feet above sea level so anything built there is at constant risk of

flooding. The Cemetery does have one advantage: old railway line (now the East Bay Bike Path) runs along its east most side, providing some elevation and likely blocking the worst of any storm surges, but regardless the whole area is at risk of flooding. There was no erosion to speak of, but this particular cemetery will be one to keep an eye on as sea levels continue to rise.

BA001 (Tyler Point Burial Ground)

(Within 0m of a flood zone) Across the Palmer river from the Warren North Burial Ground is the similar case of the Tyler Point Burial ground, located at lat 41.735334, Long-71.291239. Located on the point of the same name, this cemetery contains 300 recorded burials, of which there are 215 with inscriptions. The cemetery exists on a very shallow slope, surrounded on all but one side by a parking lot for The Striper Marina. The Cemetery itself is less than 75 feet away from the water and less than three above sea level.

Fig. 4.5.6 Tyler Point Taken facing North-West

Within the cemetery there are no obvious vectors for erosion. No running water features or other obvious erosion vectors are present. While very close to the ocean, the marina around it with its built up foundation would likely provide protection for the burials themselves. There is however the problem of storm surges. While the point does not extend directly into the Narragansett Bay, it would likely be affected by storm surge and since it is so low the stones themselves would be at risk in a bad storm. Inundation is a more likely risk factor, and given

rising sea levels this cemetery would have to be moved much sooner than others in similar situations.

CR061 (State Institution Cemetery #2)

(Within 0m of a flood zone) This cemetery is likely the most critical to protect out of any we surveyed, if not for the weight of history but for the sheer number of people buried here. State Institution Cemetery #2 is located at Lat 41.732331, Long-71.459676 at 11 Knight st in Warwick (despite being a Cranston cemetery. It is quite close to the town border). The cemetery contains 638 known burials from three different cemeteries dating from 1933 to 1940 (though burials moved here from other cemeteries may be older). State Farm Cemetery #1 was covered over and lost when the route 37 highway was built, but in 2006 flooding caused the ground beneath the road to wash out along with several coffins. These along with 57 other identifiable remains were excavated so that the road could be repaired and moved here. State Institution Cemetery #3 was moved here in June of 1975 so that the land could be developed. The 366 people buried there were dug up and put into two shipping containers that were reburied at State Institution Cemetery #2.

Fig. 4.5.7 Taken facing North-east

The cemetery itself has no obvious signs of damage, with no grade to the landscape and no obvious gullies forming. To the north is a capped landfill and to the south is the Pawtuxet

River. The river itself is about 20 to 30 feet away from the site, but this is somewhat deceptive. Looking at the river, it has a second higher bank that is within just 6 feet of a grave at its closest point. Though when we visited the river was a solid 6 feet below the level of this upper bank, the look of the land suggests that if the river were to flood the cemetery would be at risk. Though at the moment there is only one grave dangerously close to the bank the whole of it will continue to erode. Given the terrain I do not think that the site is at any risk of inundation or direct damage from tree-fall, though if one of the trees growing on the bank does fall it would lead to much faster destabilization.

Fig. 4.5.8 A View of the River from the Cemetery. Note the two banks

While this site doesn't have the urgency that a cemetery such as WR003 has, given the history behind the site and the people who were buried here (all poor, disenfranchised, or mentally ill) it should be a moral duty to protect this site in particular.

NG008 (Thomas Mumford Burial Ground)

(Within 36.3m of a flood zone) Looking at the documentation on the Rhode Island Historical Cemetery Commission's website for this yard, I realized that my first impression was not correct, but my assessment of its risk appears to hold steady. Located at Lat 41.434567,

Long-71.470333 at 179 Kingstown Rd, this yard contains 60 burials but only 4 inscriptions. Though there are 56 listed field stones I could not find any when I visited. There is no wall or fence that delineated the burial ground from the rest of the park that it was within, though the park fence and the tennis courts provided some sense of containment. The stones that were visible were located on a small terraced rise on the level of the tennis courts, about three feet above the rest of the flat ground. To the East is a small pond, about another 6 feet below that. Several trees were planted between the burial ground and the slope to the pond.

Fig. 4.5.9 What stones were visible

As far as the burials with inscriptions are concerned there is little risk. The terrace should provide decent protection, there are no obvious erosion vectors besides the pond and the small stream feeding it, and while the trees might destabilize the pond's bank they're far enough away from the terrace to not directly do damage. In terms of the 56 other burials within the site that were unmarked when I visited, they could be in more direct danger. If they're below the level of the terrace then the trees would be a much greater risk to them should they fall. Unfortunately the RIHCC lists no maps of the cemetery on their website.

One final note is that on some of my maps this cemetery was not included within the census block groups we analyzed. This appears to be a result of the projection I have been using. While it may not appear in other maps it will still be included here as an example.

NG001 (William Knowls Lot)

(Within 0m of a flood zone) Unfortunately the records and images collected on site for this lot failed to upload and are thus lost. The site is located at Lat 41.375641, Long-71.487391 on a small rise overlooking a thickly wooded swamp. The center and northwest corner are the highest points, sloping down towards the eastern and southern edges. The lot itself is in poor condition, with a collapsing stone wall and several stones overturned or broken. To the south a small stream runs eastward.

This cemetery is most comparable to WR014, though its situation is a bit more dire. While the lowest points of the cemetery are somewhat inundated already, most of the graves within the lot are decently above water. Even though it was raining while we were there the stream was tiny, less than a foot wide in places. Perhaps the dilapidated nature of this yard is a sign of erosion or loose soil, but the ground seemed stable enough when we were there. It likely would not be a risk to the site. This site, however, is close enough to the ocean that it will likely be underwater with significant enough sea level change. This cemetery may need to be moved soon.

JN079 / JN091 (Thomas Collins Lot and Rev Daniel A Jeckels Lot)

(Within 75.4m of a flood zone) These two lots are listed together here because both are on the same plot of land, roughly five feet away from each other. Thus they would likely be equally affected by any erosion, flooding, or other weather conditions. Both are located at Lat 41.863479, Long-71.491961 at 16 Mathewson St and are easily accessible from the road. Though neither has a listed number of burials kept by the RIHCC, there are 13 inscriptions in JN079 and 15 in JN091. Graves in JN079 date from 1814 to 1891, while those in JN091 date from 1837 to 1912. Around most of the site is a concrete and iron fence in decent condition. To the north east of the site is a somewhat steep slope leading down to the Woonasquatucket river, though the river itself is over 300 feet from the site, with a paved road in between.

The two lots are in almost no danger from the river, which is a good way below them. There is some risk from the slope however, as even though it is quite wooded and terraces slightly there are some signs of erosion along the slope, especially near the graveyard. About five feet down the slope from the graveyard is a flat section that then continues to drop steadily until it reaches the level of the road. There is still a few feet of space between the first area of slope and the walls of the site. The trees growing along the slope could destabilize the slope should they fall, but they aren’t big enough or near enough to the actual graves to pose a direct threat. Regardless, this is one to watch.

JN007 (Cedar Lot)

(Within 82.4m of a flood zone) Located on a small knoll overlooking Centerdale, the Cedar lot is an interesting example of the admittedly imprecise methods used catching an at risk site that wouldn't have been found otherwise. Located at Lat 41.858684, Long-71.488734, accessible by Vacca st. It is a relatively large site, containing 250 burials, 105 with inscriptions. The Oldest of these dates to 1846, the youngest to 1905. The site itself is not a unified whole, instead being made up of several small, fenced off plots with a few burials in each, all clustered together. Though we were there in early spring, it was still somewhat overgrown with several trees quite close to the graves. The small lots within are built right up to the slopes of the knoll, which quickly slope back down to ground level in the valley below. The Lot is about 320 feet away from the nearest moving water (The Woonasquatucket river).

Fig. 4.5.10 A view of part of the cemetery Looking North

Fig. 4.5.11 The worst section of erosion, sloping away from the camera

This lot is at almost no risk of inundation or flooding. Positioned suchly on top of a small hill it is unlikely that any flood water could reach it. However the erosion present is rather dire. Especially in the north eastern corner of the yard there is significant erosion present,

with several stones less than 5 feet from an eroding bank. This area is also vulnerable to fallen trees due to their close proximity to both the eroding bank and the graves themselves.

Even though this cemetery is in dire need of protection and a lucky find (as are JN079 and JN091), they don't fit as well with the others since the flood risk zones that got them flagged exist on the very edges of the 100 meter radius set. While it is lucky that these outliers were hit, there were several others that were at no risk that were likewise flagged. Thus comes the difficulty of using mapping software such as this, and why on the ground analysis is needed. Both of these topics I go more in depth in Chapter 3.5.

JN017 (Elder Stephan Sweet Lot)

(Within 0m of a flood zone) Located at Lat 41.841744, Long-71.484137, this small lot contains 42 burials, all of which appear to have inscriptions. It is slightly terraced above the level of the street (about a foot) and is located about 10 to 12 feet from a small unnamed stream. Its fence is in bad condition, reduced to just the concrete posts, and several graves are worse for wear.

Fig. 4.5.12 The Cemetery with the creek in the background

This lot is at almost no risk, even with the stream so close. The cemetery is well built up and there were no signs of erosion or other risks, and with the slight terracing it is highly unlikely to be flooded. The cemetery itself sits in a minimal flood risk zone on the RIGIS flood risk map, but given its proximity to the stream it was flagged. All this stated,

this may be one to check up on in a few years to see if the stream has changed course slightly or if any of the surrounding trees come down, but given the dense urban/suburban location the former is unlikely.

Fig. 4.5.13 The Distance between the cemetery and the creek

When I was going back and editing I found that this point should not have been listed within 0 meters of a floodway or flood zone but was. Checking the map projection revealed nothing that would suggest an error despite field observations clearly showing otherwise. Looking through my project files and notes from the field reports the correct measurements should be within 9 meters of a flood zone. Once again this is the problem with working with data like this and why such imprecise tolerances were used in the initial phases.

NP011 (Obadiah Olney Lot)

(Within 40.9 meters of a flood zone) Similar to NG001 this entry failed to upload, but screenshots were taken and images saved. Located at Lat 41.845394, Long -71.479354 at 18 Falco St, this lot faces much more pressing risks than flooding. Located about 115 feet away from the Lyman Mill Pond (part of the Woonasquatucket river). There is a slight slope towards the pond. This graveyard is listed as having 19 burials and an equal number of

Fig. 4.5.14 What Remains of the Obadia Olney Lot

descriptions, but this did not match with reality. When we visited I could only count 5, and none of those were intact. Most were partially or fully buried. There is no fence around the lot.

In terms of flooding and erosion this lot is at a slight risk. There appears to be a small gully forming as water flows into the pond, but given the shallow grade of the terrain it doesn't look like too much of an issue. The more pressing matter is to locate the missing graves and update the online entry.

PV001 (Providence North Burial Ground)

(This site is large enough that a simple distance measurement won't do. See figure 4.5.15 for a map of flood zones within the cemetery) This cemetery is one of the largest in the state, containing well over 100,000 burials over about 110 acres, of which it is estimated that only 40,000 are recorded on stones. Graves here range from 1717 right up until the modern day and the cemetery is still in use. Given the sheer size of the cemetery and the wide variety of people buried here I am focusing on the North East Section where the pauper's graves are located. This free burial site is largely segregated by race to this day. Running through the north west area of the cemetery is the Moshassuck River, though in this section of river the banks have been built up with stone walls. There are some sections where the walls are

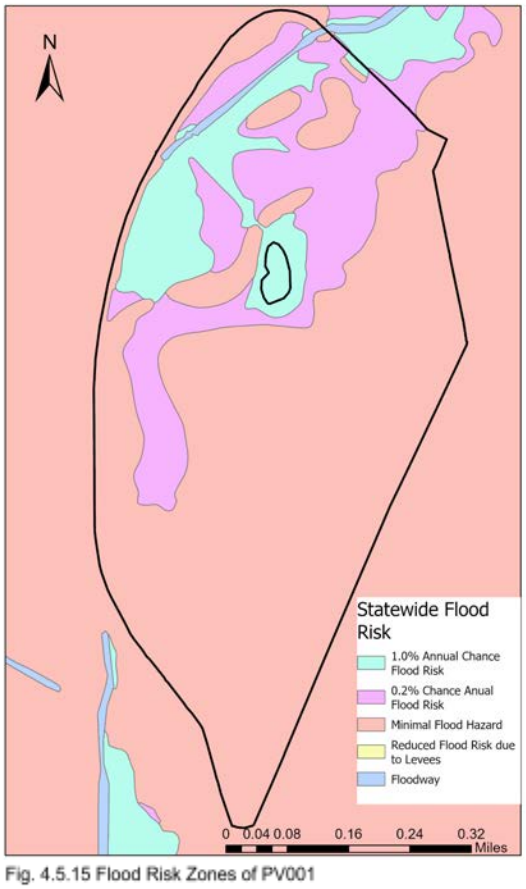

Fig. 4.5.15 Flood Risk Zones of PV001

beginning to collapse, extending out over the water slightly, though this is more on the southern side. The level of the water is about 6 feet below that of the land. To the north of the river is the largest section of the free burial ground, containing some thousands of burials. Many of those buried here were moved when I-95 was built and the highway still borders the northern and western edges of the cemetery. To the south of the river are several additional free burial plots, separated into white and colored sections.

Fig. 4.5.16 Looking Southeast from the Northmost section

Fig. 4.5.17 A closer look at the river.

The area north of the river appears to be the most at risk, though large swaths of the cemetery are flagged as flood risk zones by the RIGIS map. This section is particularly at risk due to the proximity of both the river and the highway. Rain and snow likely drains from the highway over this area of land and into the river, and thus these graves may be inundated. The river flooding is also a risk, though given the canal-like walls it would take a lot for it to flood. That being said there is always a risk of the walls collapsing and graves being taken with them. On the northern side there are markers within 6 feet of the bank, and given how

many if not most of the graves in these sections are unmarked it is possible that there are more even closer to the river.

PW003 (St Francis Cemetery)

(Again this site is large enough that a simple distance measurement won't do. See figure 4.5.18 for a map of flood zones within the cemetery) Another massive cemetery with over 125,000 graves, St Francis Cemetery is also built on the banks of the Moshassuck River. The earliest grave dates to 1871 and the newest to 1999, at least according to the RHCC. Taking up 105 acres, this is another cemetery where only a small section is at risk, but said section is many times bigger than some of the other lots listed. The area of flood risk is mostly consigned to sections 1, 2, 20, 23, 27, 60, 61, and 62, all clustered in the northeastern corner of the cemetery. In sections 1, 2, 60, 61, and 62 the ground slopes down very slightly away from the river. The next sections to the west (63 and 64) are all elevated on a hill. These five sections appear to be the lowest points of the cemetery. The river is less than two feet below the level of the ground, but this still puts the lowest points of the cemetery at or below the water level. This far north there are no longer any retaining walls, and instead there is a loose earthen bank separating the river from the cemetery, though it offers little protection. It looks like it may just be a dumping site for other dirt cleared and there are several deep gaps.

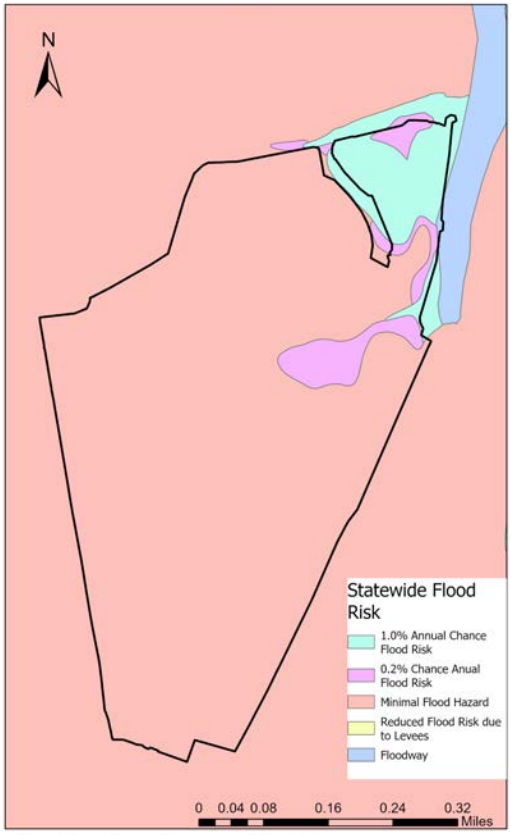

Fig. 4.5.18 Flood Risk map of PW003

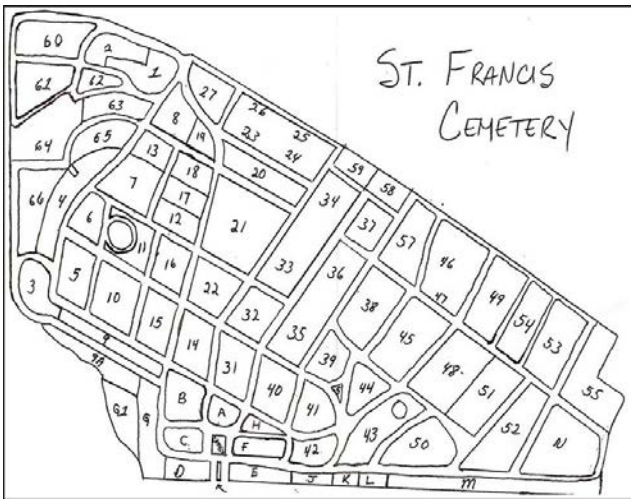

Fig. 4.5.19 Plot map of the Cemetery

These sections are at great risk from inundation. The landscape creates a natural divot that could very easily flood, should the river ever rise above its banks. This looks quite likely given the low banks around it. It does not look likely that graves are at risk of being washed out given the angle and shallowness of the grade. A bad flood may knock over or move some of the stones, the burials themselves would probably be fine. Inundation would pose a problem to their maintenance and access though, so a proper retaining wall would likely be a worthwhile investment.


Fig. 4.5.20 Looking South West. All of this flat ground is roughly level with the river, sloping downward away from it.

Chapter 5: Conclusions

I will be the first to admit that the method is not perfect. I think that the wide variety of sites sampled throughout the project should hopefully paint such a picture. The inclusion of several cemeteries not at risk due to the very generous initial search parameters. While this method was intentional as to ensure a wide selection of possible entries it did slow down the project slightly in the field work phase. However the base structure holds strong. Cemeteries that were at dramatic risk of flooding, inundation, and erosion were found using the methods outlined in previous chapters.

The main idea that this sort of mapping work relies on the assumption that these maps at least somewhat resemble the real world, and while the fine details of that assumption definitely presented themselves throughout the project it appears to be reasonably true. Cemeteries that are marked as within or near flood risk zones tend to be at risk, though there are obviously exceptions. ArcGIS successfully identified several cemeteries that were already known to be at risk from flooding, specifically Kickemuit Cemetery (WR003)[14] and the Northwestern sections of the Providence North Burial Ground (PV001). Also included were the countless cemeteries along the coast that will likely be inaccessible due to rising sea levels. This method is capable of capturing a lot of those sites most at risk, the problem is filtering out the false positives and including false negatives.

[14] Bonnie Phillips, “Historic Cemeteries Could See Grave Impacts of Climate Change in the Ocean State,” ecoRI News, October 3, 2022

The False positive problem is much easier to solve. Making the tolerances tighter and providing better filtering systems for the data available would allow the identification of cemeteries that are either not at risk or not in a position that requires immediate intervention. The Incomplete surveys are great case studies in how to better filter through sites. SK075 and SK060 are both left out if the flood risk search radius is limited. NK093, NK062, and NK044 would all be filtered out if other social vulnerability datasets were used as filters, especially property values (See Appendix A). While many of these false positives are definitely at risk and in need of attention, they are much more likely to receive the attention they would need, and thus are not the focus of this research. These methods can definitely be used for more general study by removing the filtering steps.

False Negatives are far more tricky to find. The problem with tightening tolerances to weed out false positives is that it can also create more false negatives. The False negative problem is why tolerances were specifically set loosely: so that the end result would contain a wider range of points to use and analyze. However there are some points that simply will not be flagged by the current system as at risk. Cedar Lot (JN007) is a great example of a site that was very luckily flagged by the flood risk analysis when the site was nowhere near a flood zone but was at risk. As described, the site was threatened by erosion and the risks inherent with tree-fall and the current methods have no way of accounting for these potential risk factors. If I were granted the time and resources to redo this project there would be several more avenues of study and analysis I would like to take.

Radius or Distance Measurement

The biggest problem with this method is that each cemetery listed by the RIHCC is given a single point to define its position. Though I did go into depth as to how I worked around this, the two different methods I used to work around this problem both have their ups and downs. These methods are mostly to make up for being unable to see the whole extent of every cemetery and thus potentially miss points that were marked outside of flood zones but on the ground extend much further.

Measuring the distance from each point to the nearest flood zone is by far the fastest and does have the advantage of keeping everything in one layer. It also can do a lot of what selecting for a radius does, providing distinct tiers of risk determined by distance. This method does not however give an easy way of viewing the general lay of the land around a point. By only using the one point provided this method can worsen the effects of the Modifiable areal unit problem, especially with larger cemeteries. A site could be marked as over 50 meters from a flood risk zone but the actual cemetery could easily reach for over 100 meters in that direction and the problem is worsened if the point is not in the dead center of a site.

The Radius method is better for getting a view of the site but can also suffer from the same problems. The only mitigating factor is that by creating the radius it allows for visual confirmation of the site and the area around it by looking at the result on the map. It does fall into the same pitfalls of the Distance measurement method. It is also much slower with each

radius distance requiring repeating the whole process over again instead of the one operation needed for Distance measurement.

If polygons for the extent of every single cemetery were available then this whole problem would be moot. For those cemeteries that do it is trivial to assess the risk for the most part. The cemeteries large enough to be featured in RIGIS' land use map allow for much easier visualization of risk zones. With these sites the whole can be analyzed and no further calculations are needed. If a cemetery mapped like this is partly in a flood risk zone it simply appears on the map as being partly in a flood risk zone. One assumption made throughout the project was that a site being near a flood risk zone puts it at higher risk this simply may not be the case.

Other Potential Risks

Flooding events are obviously not the only risk cemeteries must face. It is by far the easiest to quickly map with the tools I have and is no doubt a massive risk. Focusing solely on it will still miss many cemeteries at risk of factors other than flooding. FEMA in its briefs lists several other main factors to cemetery risk, such as the grade of the landscape, ease of accessibility, The status of infrastructure such as drains and roads, and a host of other factors.[15] Several of these do have data driven solutions that can be mapped out but several don't.

Looking at the slopes of the landscape around a given cemetery would be relatively easy. Topographical maps are available in ArcGIS and while it may be difficult to get them working

[15] "Making the Connection to Cemeteries," Guides to Expanding Mitigation (FEMA, June 8, 2021)

with all other points of data the general idea would be easy. If a cemetery is on or near a steep slope it would get flagged. Cemeteries such as Cedar Lot (JN007) and others like it would be flagged under much tighter tolerances then with just flood data. This however could have its own drawbacks and would likely need another semester's worth of research and analysis to get working smoothly. RIHCC also includes descriptions of the landscape in their database but this data is not in the dataset available to download and the descriptions themselves are too short to be of much use besides filtering. Some simply don't have the information.

With issues of funding, accessibility, and care the hope was that including analysis of social risk would catch these cemeteries. As previously mentioned a key assumption in this project was that cemeteries in socially disadvantaged areas would have fewer resources put towards maintenance and protection and thus would be at higher risk. Cemeteries that have no full time staff caring for them are at a higher risk of all forms of damage then cemeteries that do. The RIHCC does provide some data on the general state of a cemetery such as if it is fenced off, if stones are damaged, etc. but the full breadth of risk is still not accounted for. To truly get an accurate picture of the risks posed by lack of funding a monumental amount of time and effort would need to be put into on the ground research and communication with those in charge of maintaining these cemeteries. This is why this project is so important.

Final Conclusion

Cemeteries are places for the dead, and in that manner are places for people and nothing else. They are hugely important to us, not just as places of historical research but for community,

remembrance, and connection with the past. Given the risk that they face, action is needed. The Whole purpose of this project has been to provide a framework for future work. The task at hand is staggering: dozens of cemeteries are at dire risk, hundreds more are threatened. This is to say nothing of all the cemeteries not in Rhode Island that are equally at risk. The point of this project is not to immediately solve any of these problems. I doubt I could. But hopefully through the creation of these maps and the tools and processes used to build them I have provided a framework for future action.

This project strives to identify those cemeteries most at risk so that they can be helped, protected, and potentially moved out of danger first. Cemeteries that house those most vulnerable of people who are thus most deserving of protection in death. With the maps created these places of rest have been identified and action can now be done to protect them. But this is still just the first step. The time and resources necessary to protect these places of culture and reverence will be staggering, but I believe it is with it. We owe it to the people buried in our nation. To the people buried in State Institution Cemetery #2 inside two shipping containers when no one was able to claim them. These people deserve rest but most importantly they deserve protection. We cannot forget what happened to these people. They may be dead but once they lived and it is our duty to remember this. It is our duty to protect them.

Appendix A: Incomplete Field Reports

The previously listed 13 cemeteries were all visited, photographed, and had reports drafted, but they were not the only cemeteries we visited (or tried to visit). There were several more that we could have drafted reports for but chose not to, either because they were inaccessible, they did not exist, or they were not in a high risk zone despite the declaration of such by the ArcGIS maps. Again this comes down to the modifiable areal unit problem and the difficulties of drawing boundaries. My best explanations for why these points weren't included will be listed below.

SK031

(Within 17.5 meters of a flood zone) Located at Lat 41.463172, Long -71.494172. While from satellite photos it looks like a great candidate, it was far enough in the woods behind private property that we couldn't find a way to reach it, and so left it for someone else to inspect.

SK064

(Within 0 meters of a flood zone) Previously located at Lat 41.461030, Long -71.494340, this site no longer exists. RIHCC makes no note of any burials being moved, so the site may still exist, but we faced the same problems as SK031.

NP017

(Within 24.3 meters of a flood zone) Located at Lat 41.840578, Long -71.476672, again on the Lyman Mill Pond. The cemetery was behind several locked gates and we didn't want to trespass, nor could we find an easy way of doing so.

JN083

(Within 85.8 meters of a flood zone) Located at Lat 41.864131, long -71.493019 behind 21 Cottage St. It is located behind a private residence and not visible from the road. Checking for it with satellite images returned nothing, so it may not be there any more.

PV011

(Within 96.5 meters of a flood zone) Located at Lat 41.8313333, long -71.4099361. This is in the heart of Providence and like previous entries only had flood risks at the very edge of its 100 meter radius. However this section was mitigated by levies and the cemetery itself was some distance up the hill from the river so we chose not to visit.

NK093, NK062, and NK044

(all within 0 meters of a flood zone) All three of these cemeteries are located very close to the ocean and to each other, but the decision was made not to include them because of their location. All three cemeteries were located in Wickford, which boasts some of the highest property values in the state. Despite the risk from sea level rise that these burials face, they are not being considered here for this reason.

SK075 and SK060

(Within 68.9 meters of a flood zone) Located at Lat 41.449767, Long -71.511703, both of these points are technically part of SK036, the New Saint Francis Cemetery in South Kingstown. Located about a good distance away from and tens of feet above the nearest lake, we decided there was little risk. Some on foot exploration was done but there was nothing to cause alarm so we moved on.

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