WATER COMMODIFICATION IN THE LOWER RIO GRANDE VALLEY, TEXAS

A Senior Scholars Thesis

by

BIANCA GARCIA AND MANUEL HERNANDEZ JR.

Submitted to the Office of Undergraduate Research
Texas A&M University
in partial fulfillment of the requirements for the designation as

UNDERGRADUATE RESEARCH SCHOLAR

April 2011

Major: Environmental Studies and Environmental Geosciences

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Approved by:

Research Advisor:	Wendy E. Jepson
Director for Honors and Undergraduate Research:	Sumana Datta

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ABSTRACT

Water Commodification in the Lower Rio Grande Valley, Texas.
(April 2011)

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The lower Rio Grande Valley of Texas is one of the poorest regions with the largest population lacking suitable water supply in the entire United States. The region is characterized by low-income, rural and peri-urban communities called "colonias." Nearly half of the 238,000 colonia residents face known infrastructure deficiencies in water, sanitation, or both, while nearly one-fifth have unknown water and sanitation status. The commodification of water quality through water vendors has expanded rapidly throughout South Texas, questioning their motives for positioning their businesses in certain locations. We will explore the relationship between poverty and water vending through a spatial analysis using a Geographic Information System. Our analysis revealed significant correlations between demographic variables and water vending unit locations. The spatial distribution was strong in relation to colonia locations, confirming the belief that water companies placed water vending units for the region's poor communities.

DEDICATION

We would like to dedicate this thesis to everyone that supported us through the creation of this project.

ACKNOWLEDGMENTS

We would like to thank our advisor, Dr. Wendy E. Jepson, for her guidance, patience, and support throughout this project. This project wouldn't have occurred without her knowledge and passion for the study area. Also, we would like to thank Miriam Olivares and Iliyana Dobreva for their technical assistance with the ArcGIS software.

NOMENCLATURE

EPA	Environmental Protection Agency
FDA	U.S. Food and Drug Administration
GIS	Geographic Information Systems
LRGV	Lower Rio Grande Valley
NRDC	Natural Resources Defense Council
SDWA	Safe Drinking Water Act
TCEQ	Texas Commission on Environmental Quality

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CHAPTER I

INTRODUCTION

Every human being is entitled to the basic human right of having clean water. Yet over the past twenty years, drinking water has been transformed from a public good to a commodity (Gleick, 2011). The commodification of bottled water has increased through globalization, becoming readily available to the public (Klessig, 2004). Despite the availability and cost of tap water, people are willing to spend great amounts of money to ensure they receive "good quality water" that many bottle water companies promise them (Doria, 2006). Many Americans believe that bottled water is a necessity; not only is it more convenient, but it is believed to be healthier than tap water. Water as a commodity is a part of the fastest growing and least-regulated industries in the world (Barlow & Clarke, 2002; Lewis, 2010).

The recent bottled water craze has left American's "obsessed" with bottled water. The bottled water industry grosses hundreds of millions of dollars per year (Gleick, 2010). Each year, sales for bottled water continue to increase. In 2001 alone, more than 5.4 billion gallons of bottled water were sold to and consumed by the American public (Boldt-Van Rooy, 2003: 273) yet by 2008, this volume almost doubled, as nearly 9 billion gallons were packaged and sold in the United States (Gleick, 2010: 5).

This thesis follows the style of *Geoforum*.

Consumer's predisposition of bottled water over tap water differs between each person. One person may prefer bottled water because of the certain taste while another person may view bottled water as part of the modern lifestyle and a status symbol (Parag & Roberts, 2009). One source confirms American preference for bottled water, as they drink more bottled water than beer or milk, around 30 gallons per year (Gleick, 2010: 6). As one critic wrote, there is an advertising "war on tap water" that has increased consumer preference for bottled water over tap water (Gleick, 2010: 10). This idea of pure and safe drinking water has been instilled in consumer's heads due to bottled water companies creating the image that tap water is inferior to bottled which in turn develops distrust of the quality of tap water in the minds of consumers (Parag & Roberts, 2009).

The Lower Rio-Grande Valley (LRGV) is an area located in south Texas, along the border of the United States and Mexico. In the residential areas in the LRGV, colonias, have faced problems associated with water, which includes water quality and access (Haynes, 1977). The quality of water in the LRGV is affected primarily by pollution. The pollution from wastewater plants, known as "point sources", and "nonpoint" sources that include contaminants that run off due to rainfall from parking lots and agricultural fields affect the water quality. To help solve this problem, an agency known as the Lower Rio Grande Valley Development Council has served since 1975 to aid in the management of water quality with help from the EPA and TCEQ (LRGVDC, 2009). However, there are still communities with little or no access and a strong belief that the water provided to the colonias is not good (Jepson, personal communication; field notes).

Water vending companies have been commercializing the access to clean water to the region's population. The companies have built water vending machines, such as Watermills or "molinitos", throughout areas of the LRGV to fulfill a market need for purified drinking water. Customers supply their own containers and drive up to the different water vending locations to purchase purified water at a fraction of the price they would pay for bottled water. There are four water vending companies that we will further investigate their methods of advertising, technology, demographic market, and distribution locations. These four companies include Watermill Express, Avant, Aquamax, and Waterplex.

In this thesis we will describe the water vending industry in the Lower Rio Grande Valley, located in the southern Texas-Mexico border. This area is one of the poorest regions and one of the largest concentrations of Hispanics in the United States. Unlike the commodification of bottled water for the wealthy, the emergence of the water vending purified water economy in the South Texas targets low-income residents who have historically lacked access to water or who have access to shoddy public services that supply water. Therefore, this chapter provides the background necessary to situate the emergence of water vending to poor residence in the Lower Rio Grande Valley. The first section reviews the current literature on bottled water industry, paying attention to the process of water commodification to elites. It is then followed by two sections that review the problems of bottled water industry, focusing on the environmental impacts and the technological innovations that support the new packaging and delivery of drinking water to consumers. The final section demonstrates that while we know much about water vending to the wealthy, there is little information on the process of drinking water commodification to the poor. We argue that a study on water vending to low income communities will add to the broader literature on water commodification through bottling and provide new insights into the underlying economic assessment of benefits and costs related to selling purified drinking water to the poor rather than provide through public services.

The bottled water industry– a historical overview

Water suppliers comprise of private firms that distribute bottled water, semiprivate water agencies that distribute tap water, autonomous state water authorities, and branches of local government. These water suppliers distribute different types of bottled water. The quality of this water is relayed to the consumers through information provided by the monitoring authority (Parag & Roberts, 2009). The different types of bottled water include spring, purified, mineral, and sparkling. Spring water is defined as bottled water derived from an underground formation from which water flows naturally to the surface of the earth. This type of water must be collected only at the spring or through a borehole tapping the underground formation feeding the spring. Purified water is created through treatment processes such as distillation, deionization or reverse osmosis. Mineral water is the constant level and relative proportions of mineral and trace elements at the point of emergence from the source. Finally, sparkling water contains the same amount of carbon dioxide that it had when it surfaced from its source (Blaurock-Busch, 2009; Gleick, 2011). These are the main types of bottled water that most American's prefer to consume. Despite the fact that the bottled water industry has gained popularity over the last several years, it still has its fair share of setbacks.

With the amount of revenue coming in from the water bottle industry, many wonder when this dependence on "purified" water started. In the 1970's, water bottle production began to expand throughout the country at a consistent rate. In the past many Americans did not drink as much water as today, thus the water bottle business was relatively small. It was only in the 1980's when the industry began to expand at a rapid pace, making it the fastest rising aspect of the bottling and beverage industry. Its revenue increased by 93% between 1976 and 1980, with total revenues about $440 million (Coca Cola, 1996). In 1980, companies looked to the United States to begin selling bottled water by advertising in a way that would attract consumers to the idea of "healthy and cleaner" water (Coca Cola, 1996). To this day, the United States continues to be a top nation, followed by Europe, with a high number of water consumption in regards to bottled water.

Around the late 1970's and early 1980's, businesses began tapping into the bottle water industry as many Americans were drawn into the idea of having safe "bottled" water. At this time, large bottle water companies have set aside a large percentage of their revenues to be directed towards advertisement, since image has been the key ingredient to its top dollars earned. Perrier, now known as one of the top leading bottle water companies, has been one of the first corporations to look into turning water to a commodity. Gustave Leven, chairman of Source Perrier, partnered up with Bruce Nevins, who worked for athletic-wear company Pony (Fishman, 2007). Nevins created a three-part strategy to convince Americans that bottled water is the beverage to consume. Nevins was able to tie in health by having Perrier sponsor a marathon, have celebrity commercials, and flew in several journalists to introduce them to the source of their water (Fishman, 2007).

Americans were captivated by bottled water, and Perrier's sales' reflected that trend as second—year profits tripled in revenue. Perrier's introduction of bottled water allowed for other companies to join the "blue gold" rush. Evian, another leading water bottle company, started off in the United States in 1984 (Fishman, 2007). Its marketing strategy revolved around images of young men and women in the gym with tight clothes and having Madonna drink Evian while in concert. Interestingly, Evian was the first company to present its water in a plastic bottle. There advertisement idea was to show people how their water was clean and delicious. Poland Spring, a top water bottle company, started off with providing water towards resort and spa complexes. Since water was their main revenue, Poland Spring put all of its focus on bottled water once their resort burned down in 1976, right around the time the water bottle industry began to bloom (Fishman, 2007).

Bottled water is regulated by the U.S. Food and Drug Administration (FDA) as a food product. Therefore, bottled water companies must comply with requirements established by the FDA. These requirements include quality, labeling, and manufacturing practices. These companies must also comply with state restrictions with methods for collecting water, standards for bottled water, and trade industry regulations (Boldt-Van Rooy, 2003). Despite these requirements and FDA guidelines, water scholar Peter Gleick recently demonstrated that bottled water is less regulated than tap water, which is regulated by the Safe Drinking Water Act (SDWA) (Gleick, 2011). Others have challenged the clean image of "pure spring water" through brands like Nestle but this water may not always be safer than tap water. A 1999 study conducted by the US based Natural Resources Defense

Council (NRDC) discovered that one third of the 103 brands of water contained levels of contamination that included traces of E. coli and arsenic (Barlow & Clarke, 2002).

Problems with the bottled water industry

Our global water industry is dominated by ten corporate players mostly based out of Europe, which are divided into three tiers. The first tier is made up of the two most powerful water companies in the world, Vivendi Universal and Suez, both based out of France. These two companies control over 70 percent of the world water market. The second tier is comprised of four corporations, Bouygues-SAUR, RWE-Thames Water, Bechtel-United Utilities, and Enron-Azurix. The third tier consists of smaller water companies including three British companies and a US based enterprise. The British companies include Severn Trent, Anglian Water, and the Kelda Group. American Water Works Company is the US based company (Barlow & Clarke, 2002).

A group of four bottled water companies dominate the United States bottled water marketplace. These companies are known as “The Big Four” and they include Nestlé/Perrier Group of America, Danone Waters of North America, Pepsi, and Coca-Cola. The soft drink company, Pepsi, is the number one seller of bottled water at retail stores with its line of purified municipal tap water, Aquafina. Coca-Cola also sells purified municipal tap water under its brand, Dasani. In 1992, over 700 brands of bottled water appeared on the shelves of stores all over the United States. Nestlé/Perrier Group of America dominates in the world market with almost 16% of all bottled water sales (Boldt-Van Rooy, 2003). At the present time, we have seen seven large bottled water companies rise to the top in an industry that has been known as the fastest growing area in the beverage market (Excel Water Technologies, 2007). Those companies include Perrier, Evian, Naya, Poland Spring, Clearly Canadian, La Croix, and Purely Alaskan (Barlow & Clarke, 2002). The bottled water industry has negatively affected the local and global environments. Environmental degradation from the bottled water industry is seen through the collection, processing, packaging, transport, and disposal processes. The extraction and processing of oil and other raw materials to create the plastic used for the bottles add to the degradation (Parag & Roberts, 2009; Ferrier, 2001; Howard, 2003; Jungbluth, 2005). Water-bottling corporations have been buying farmland in rural communities to access wells and moving on once the wells have been depleted of water supplies. Once the corporations have removed areas of their water supplies, they are not obligated to pay any fees for the extraction of the water like in other industries such as oil and timber (Barlow & Clarke, 2002). Damages caused by the bottled water industry are not limited to ground water deterioration (Lewis, 2010). In places such as the southwest United States, sizable bottling plants are depleting rare oasis environments. Whereas in more humid environments, aquifers have dropped, thus causing desiccation to the wetlands in some instances (Lewis, 2010).

Along with ground water depletion, industry utilizes a considerable amount of energy while its waste (plastic bottles) adds volume to landfills. Most of the energy used by the industry comes from the manufacturing and distribution of plastic bottles. According to Gleick (2010), the energy consumption was between 100 and 160 million barrels of oil in 2007 (Lewis, 2010). Recently, bottled water companies have reduced the amount of plastic in their water bottles because of much criticism that they have generated a substantial stream of plastic waste. By reducing the plastic contained in their bottles, companies have emphasized recycling and are testing biodegradable containers. Although, there are some problems associated with these biodegradable containers. These containers decompose poorly and could possibly end up contaminating the recycling stream (Lewis, 2010).

Technology of bottled water industries: case of purified water

With the growth of bottled water, industries are focusing on the equipment necessary to provide this purified water for different plants. Unlike spring water or glacial water, purified water is tap water that has been further transformed through a technological process. With advanced technology, companies have been able to decontaminate water. Bottle water companies have advertised themselves on having clean, safe drinking water that has gone through countless purification methods, thus meaning any impurities have been removed.

First, surface water flows through a process of purification by taking water from surface sources and running it through to become tap water, regulated by the EPA under the SDWA. This includes techniques such as sand filtration, flocculation, and the addition of chlorine to eliminate contaminants found in water (Drink More Water; EWT, 2007). Although, this addition of chlorine can be harmful to your body and has been linked to different cancers, it does play the role of killing microorganisms in the water that can make you severely ill (Drink More Water).

Bottled water industries claim to treat tap water and take the necessary steps to turn acceptable EPA water into healthy, " purified water" through a series of water purification methods. One of the most widely used methods used by companies is to take municipal water and run it through several filtrations. This allows for further purification and removal of contaminants such as chlorine, organic solvents, pesticides, chloride oxide, and other pollutants. Reverse osmosis is a type of filtration method of which is chemically pure water from virtually any sources (Watek, 1993). This method of filtration is a widespread in the bottled water industry, removing impurities and other contaminants with both low energy consumption and maintenance costs. Another filtration method that is commonly used in the bottled water industry is known as distillation, which deals with the initial boiling point of water. It separates the substances in water since there is a difference in boiling points, and then the vapor goes through a cooling process (Watek, 1993). Also, demineralization is known as another purification process used by water bottle industries. This purification method captures ions through an ion exchanger and exchanges salts for hydrogen and hydrate oxide ions (Watek, 1993). These dissolved salts are then removed through cation and anion exchangers. Once that is done, the water goes through a regeneration process by using hydrochloric acid and sodium hydroxide.

Water companies have been known to use different methods to reach its purified water that is safe and healthy, but researchers have found this is untrue at times. According to an epidemiological study conducted by Payment et. al (1997), gastrointestinal illness can occur with the consumption of purified drinking water even if it passes the current drinking water standard. With carefully set advertisement, some companies are able to take purified water that has already gone through a process of removing contaminants and add another purification step (Drink More Water). Advertisement is then sent out to the public of its intense purification process, making the public believe this water is far safer than regular tap water. In the end, technological advances have allowed for bottled water industries to grow in a business that has increased in revenue at an exponential rate.

Purified water in the lower Rio Grande Valley

Water vending locations can easily be identified by their unique appearance. With large advertisement banners and signature watermills, water vending companies have been able to attract a consistent amount of business as time continues to progress (Figure 1). Watermill Express has been a prominent vending business in the LRGV, advertising their purified drinking water through their infamous watermills (*molinitos*). These well-known watermills have all the components people look for: convenience, appearance, and confidence in water they are consuming. The advertising tactics displayed at most watermills will have some sort of description of their water that will lure consumer's to want to purchase their water. For example, an advertisement on these watermills will read "Try Our Water. You'll Love it!" or "Great Water." These advertisements are even translated to Spanish, which will attract their target Hispanic audience wherever these watermills are located. Watermill Express has recently taken a direct route in ensuring their quality in advertisement. The water company has limited access to information available to the public to view. Such information includes accessible locations of their watermills via internet and telephone, technology used throughout their watermill chains, and overall advertisement ideas to contend with other companies in the water industry.

With the ease of locating and maneuvering around these watermills, further shown through a Geographic Information System, communities are willing to pay the necessary funds to receive safe and reliable drinking water.

Figure 1: An example of a water vendor's advertisement image.

Water vendors in the Lower Rio Grande Valley have taken different approaches when compared to the water bottle industries. Advertisement is a key component that brings in profit to many bottled water companies. While this may be true for bottled water advertisement, water vendors in the Lower Rio Grande Valley tend to place their business around areas where consumers have easy access to and can be seen from all directions, as seen on Figure 1. Demographically, water vendors in the LRGV seem to target low-income populations, not the wealthy. Compared to these water vendors, bottled water industries target historically wealthy, health conscious populations, focusing on different age groups and other subjects relating to its bottled water.

This research project fills a gap in current understanding of the economics of bottled water industry because we focus our attention to the rise of purified water among low income communities. We will analyze location data of water vending units in a Geographic Information System to explore the reason behind why water-vending companies place their units in certain areas. We want to establish the hypothesis that low-income and ancillary demographic data (access to transportation, education) are predictors of water-vending location. Our main focus will center on distribution with the four water companies that operate in their region. It is important to have a firm understanding on how business, such as Watermill Express and Avant, profit from their privatization of water as the Lower Rio Grande Valley struggles with low water quality in their homes. The next chapter will review in detail the methods that we will employ to describe the process of water commodification through the purified water industry in south Texas.

CHAPTER II

METHODS

Our main research objective centers on the idea of the commodification of water rely on the rapid expansion of water vendors near low-income areas in South Texas. Through our exploration of this swift development and its direct link towards households, we will be able to explain the fundamental idea behind corporation's tactics and perceived thoughts populations have concerning "safe and clean" drinking water. This chapter outlines the main study area, the Lower Rio Grande Valley, more specifically, the peri-urban communities, known as colonias. Following that, we will discuss the different methods used to carry out our hypothesis.

Study region

The study region is the Lower Rio Grande Valley (LRGV), specifically Hidalgo County, located in the extreme Southern tip of Texas, which lies just on the Northern Bank of the Rio Grande River. The region is made up of four counties: Hidalgo County, Cameron County, Starr County, and Willacy County. The LRGV spreads over approximately 4900 sq. miles, and has an estimated population of just over 1.17 million people (2009 est.) Hidalgo County is the largest and most populous of the 4 counties, with approximately 700,000 people living in the county. Brownsville, McAllen, and Harlingen are the largest and most important cities in the area.

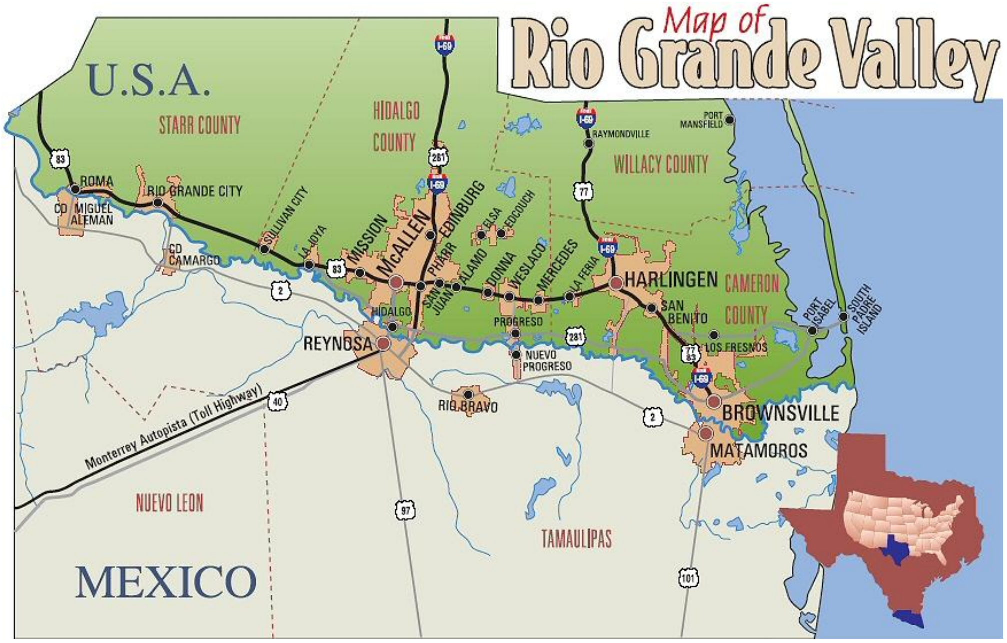

Figure 2: Map of LRGV

http://webhost.bridgew.edu/jhayesboh/counties/tx.htm

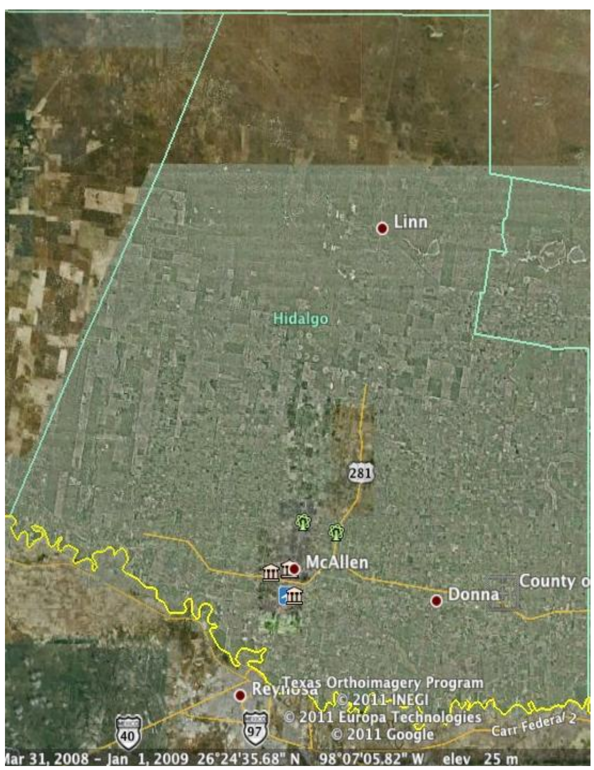

Figure 3: Google Earth image of Hidalgo County

Hidalgo County is one of the fastest growing counties in the nation, with this increase aiding in the development of more colonias to the area. Just west of Hidalgo County lies Starr County, as seen in Figure 2, which is one of the poorest counties in the nation, with a per-capita income of less than $10,000, with the entire LRGV as whole only having an average per-capita income of just over $13,000. Figure 3 displays the Google Earth image of Hidalgo County, TX.

Table 1: U.S. Census Bureau: 2005-2009 American Community Survey 5-Year Estimates

	Rio Grande Valley	**Texas**	**U.S.**
% of pop. High School graduate or higher	59.7 %	79.3 %	84.6 %
% of pop. Bachelor's degree or higher	14.6 %	25.4 %	27.5 %
Median Household Income	$29,476	$48,199	$51,425
Median Family Income	$31,584	$56,650	$62,363
Per Capita Income	$13,008	$24,318	$27,041
% Families living below poverty level	31.9 %	13.2 %	9.9 %
% Individuals living below poverty level	36.3 %	16.8 %	13.5 %
% Hispanic or Latino (of any race)	88.7 %	35.9 %	15.1 %

The communities of interest in the study are the colonias in Hidalgo County, situated only a few miles out of cities such as McAllen and Mission. This study of these low-income areas is necessary, especially if water quality security and other essential infrastructure things are to be guaranteed to colonia residents. Table 1 depicts different demographic variable percentages in relation to the Rio Grande Valley, Texas, and the United States. The table below depicts the number of colonias in each of the LRGV counties with their respective populations (Table 2). The severity of water security in the colonias is also portrayed by the different colors. Green would signify good water security, yellow indicating mediocre water security conditions, and red denoting poor water security conditions.

Table 2: Colonias classification and population 2006

	Cameron			Hidalgo			Starr		
Type	#	Pop.	Total (%)	#	Pop.	Total (%)	#	Pop.	Total (%)
Green	93	25,753	54	270	42,748	27	96	15,631	45
Yellow	41	17,067	36	267	54,283	35	33	6,108	18
Red	42	4,786	10	136	17,253	11	105	12,885	37
Unknown	2	---	---	261	41,848	27	2	118	< 1
Total	178	47,606		934	156,132		236	34,742	

Analytical components

Through our main research topic and past studies that have relied on the software that pertains to Geographic Information Systems (GIS), it is imperative to understand what past researchers have implemented in their own work as the software continues to advance. Geographic Information Systems, or more commonly GIS, is a system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data (Konkel, 2010). The manipulation of spatial data and its software has grown exponentially, used in many aspects in today's society. Furthermore, ongoing research focused water security in the lower Rio Grande Valley has allowed our research team to extract spatial data used directly to expand our own research topic.

Glimpses of geographic mapping have been seen since ancient times, with the mid 1800's and early 1900's being important contributing factors (Pacific Island Travel, 2007). During the 1960's, Geographic Information Systems blossomed into its first operational system and has continued to grow ever since then. Within our own research, our team has seen the improvements in its latest version as we incorporated different sets of data into the mapping system. Unfortunately, there has been a limited amount of past studies that have been geared towards the issues of bottled water in the Lower Rio Grande Valley. Through numerous sources such as ongoing research in Household Water Security in South Texas Colonias (Jepson, 2009); our research team developed a unique dataset with several data features. Our data set included three different sets of shapefiles that were each taken from multiple sources. Our shapefile for the colonias' held data of the level of water security its populations had. Futhermore, we created a data set using several methods such as Google Earth and company web pages to pin point water vendor business locations. Also, our third shapefile included data from the 2010 Census data. Multiple data sets went into creating this third shapefile that would hint if water vendors take into account collected census information. Using these data in a GIS, we will examine the spatial relationship between demographic information and the placement of these businesses. We will also examine their relationship to colonias communities.

Data sources

We had to build our dataset from disparate sources. Through the ongoing project of Household Water Security in South Texas Colonias (Jepson, 2009), we accessed the county shapefile, which stores nontopological geometry and attribute information for the spatial features in a dataset.

First, we had to geolocate water vending units. Our main focus was on four water vendor businesses that included Avant, Aquamax, Watermill, and Waterplex. Numerous web pages including company websites, yellow pages, and Google Earth provided us with the necessary information such as addresses to create a feature with the locations of these water vendor businesses. For locations that were not available for different reasons (competitive industry, copyright laws, etc), our team used local (field) information, entailing local knowledge of the study area and bottled water business locations. A research member documented the exact location of the business and incorporated it into the mapped system. The feature, which is homogeneous collections of common features, each having the same spatial representation, acquired for the locations of the bottled water businesses, was configured by digitizing their location in the mapped system and representing their position through a point. Once all the data was gathered, we positioned its locations onto ArcMap one by one, using Google Earth as a reference point of placement for our own map and placed similar projected coordinate system, which references a particular place on the Earth, which in this case was geared towards North America, as the other features on our map. This allowed our team the flexibility to include points in the later future. Once placed into position, its feature was projected onto our two dimensional plane.

We also extracted data from the US Census. The census data has also been essential to our research through its large amounts of detailed data. Although the United States government collected census data for the year 2010, numerous data sets that have been gathered have held gaps between years. Therefore, our collected census data reflected a complete set of information from the census year 2000. Businesses, including water vendors, will focus on complete data sets to make key decisions in placement of their production s. Our shapefiles and its excel format data was acquired from the Geolytics website (Cornelius, 1991), with of their main focuses being on demographic data and estimates. Through this website, we specified what year, the level of accuracy, and the detailed information that was needed. Through census tracts, which are small, relatively permanent statistical subdivisions of a county offered to the public by the U.S. census, we were able to create a shapefile from the Geolytics website. Our team extracted numerous types of data sets, including number of vehicles per household, household income, and household education levels, each including numerous sub data information such as Once our file was created, we inputted our shapefile into ArcMap and projecting its data to match our other shapefile coordinate systems.

USGS data was the colonias data. Through the process of building upon the foundation of the mapped system in ArcGIS, its features also had to be transferred and given similar projected coordinated systems onto the established map as our other features. From there, we turned the colonia's polygons into points by using ArcMap's Polygon to Point command. This centroid points of the colonia's were labeled as being one each and compiled into an excel sheet. These maps will aid in assessing how water companies view the study region and make key decisions in their business placement.

Spatial analysis

We employed two types of spatial analysis to the research problem. First, we employed a buffer analysis around the vending units to identify areas surrounding geographic features inside its designated boundaries. Doughnut shaped buffers of distances of 1 and 2 kilometers were placed around the bottled water business locations. Within the 2 kilometer buffer, a Dissolved feature was placed so that if any buffers in that range overlapped each other, a combined buffer would take its place. Unlike the 2 kilometer buffer, the 1 kilometer buffer was left to overlap each other since only a limited amount of buffers crossed each other. Through this analysis, our team explored correlations between the locations of bottled water business and the levels of water security in the colonia regions. Furthermore, through the spatial analysis, an additional investigation of placement of business in regards to local competitors. The innermost ring of 1 kilometer was placed to have a more refine scope of the water business site and its association to colonias. Each point, or centroid, was accounted for, each being represented with a numerical value of one if true. Once our information was complete, our team began a statistical analysis by doing a Pearson correlation between the dependent variable (water vendors) and the independent variable (colonias of the LRGV).

CHAPTER III

RESULTS

Quantitative results

By means of spatial analysis through GIS mapping systems, numerous maps were produced to demonstrate any correlations with placement of bottled water businesses in Hidalgo County. Figures 4 and 5 describe the bottled water company, Aquamax, in relation to colonia regions in Hidalgo County at different distances. Aquamax has no distinct correlations as it holds two businesses in Hidalgo County. Its buffered region shows no clear indication if it takes into account the location of colonia regions surrounding it. Figures 6 and 7 depict a high number of businesses in Hidalgo County, with a greater focus in the center of the region. The water company Avant is represented in these two figures. These figures express a greater amount of colonias that are inside either the buffer region of 1 kilometer, 2 kilometers, or both. Figures 8 and 9 also feature numerous buffered regions by the company Watermill Express, at different distances, in their points that encompass different levels of water security in the colonia regions. With limited amount of information released by Watermill Express, its map gears their points towards the western central area of Hidalgo County. Figures 10 and11 illustrate the water vending locations of Waterplex that are geared toward the eastern area of Hidalgo County with individual locations being spread evenly from each other. Furthermore, the buffer regions include some of the colonia areas while being evenly spread apart from each water vending site. The figures illustrating these values can be viewed on pages 23 through 30.

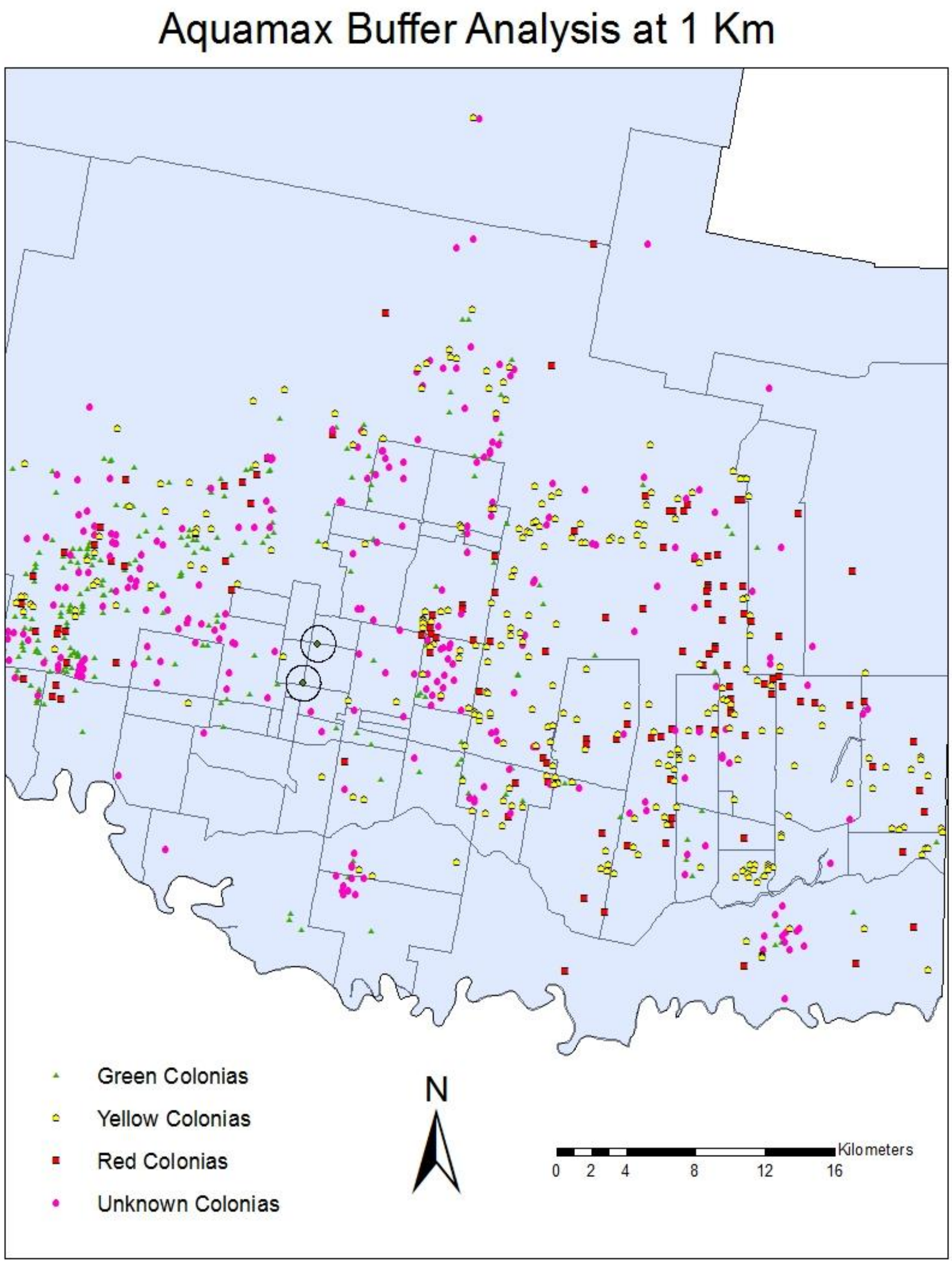

Figure 4: Aquamax buffer analysis at 1 kilometer

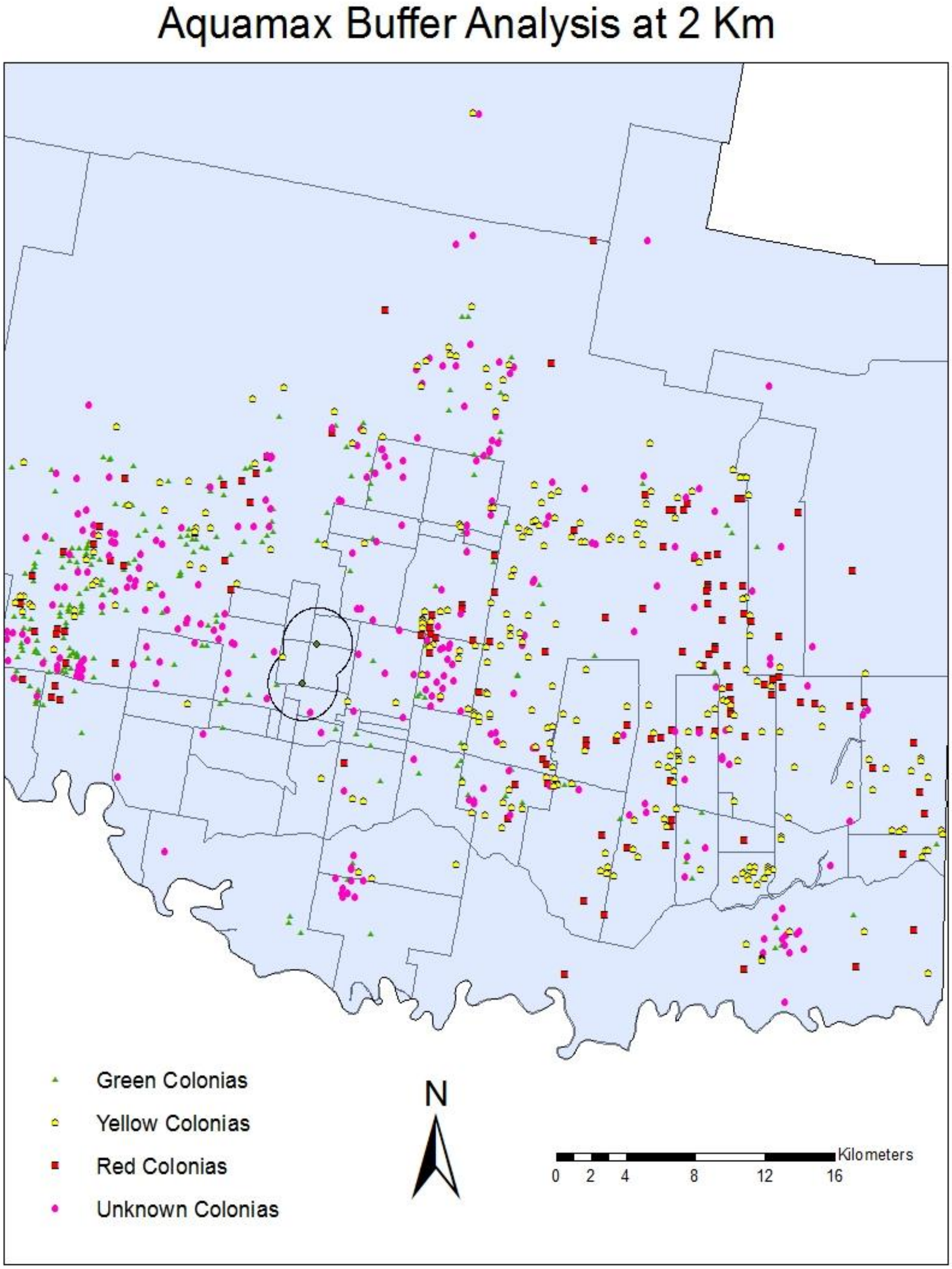

Figure 5: Aquamax buffer analysis at 2 kilometers

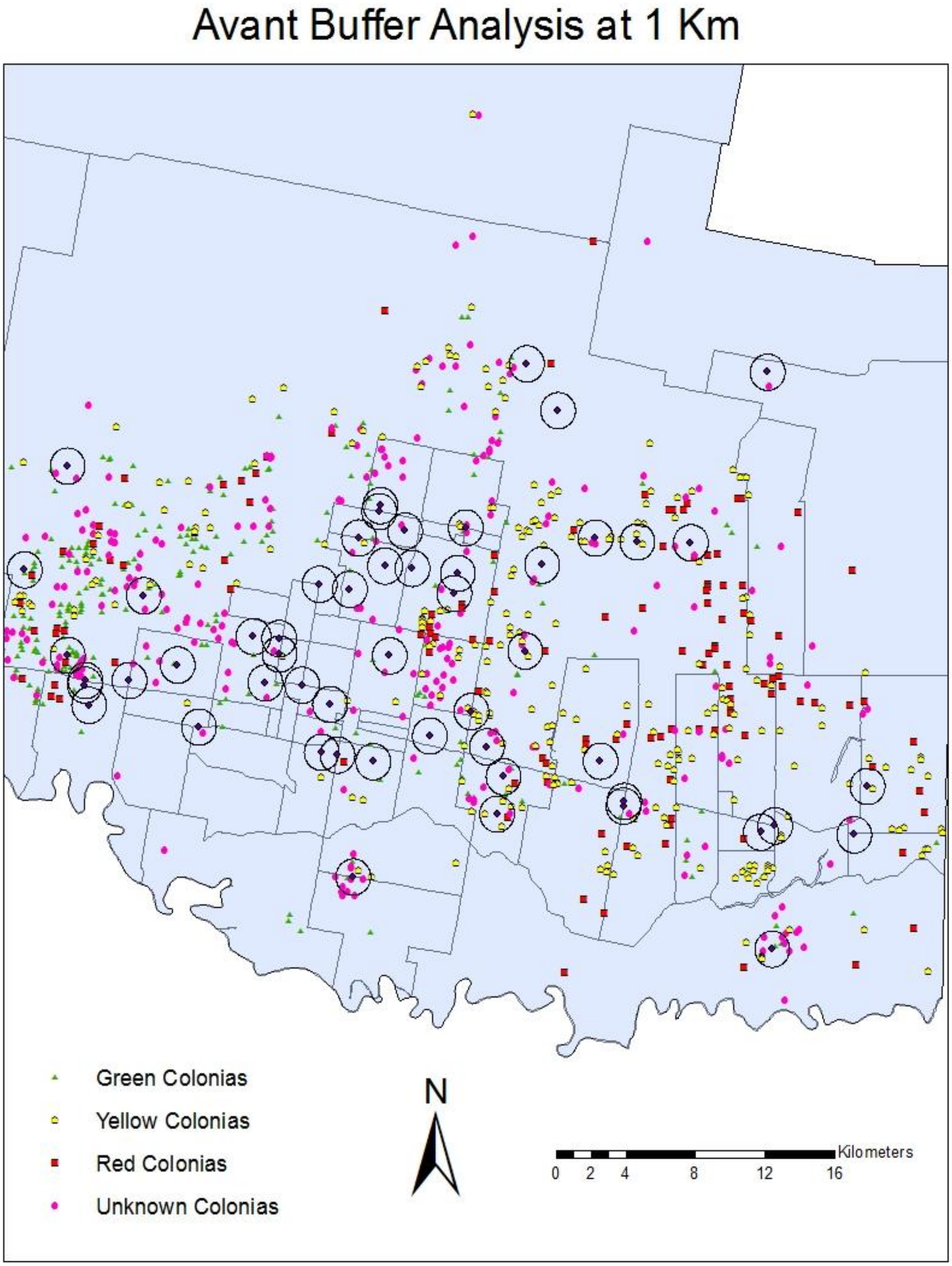

Figure 6: Avant buffer analysis at 1 kilometer

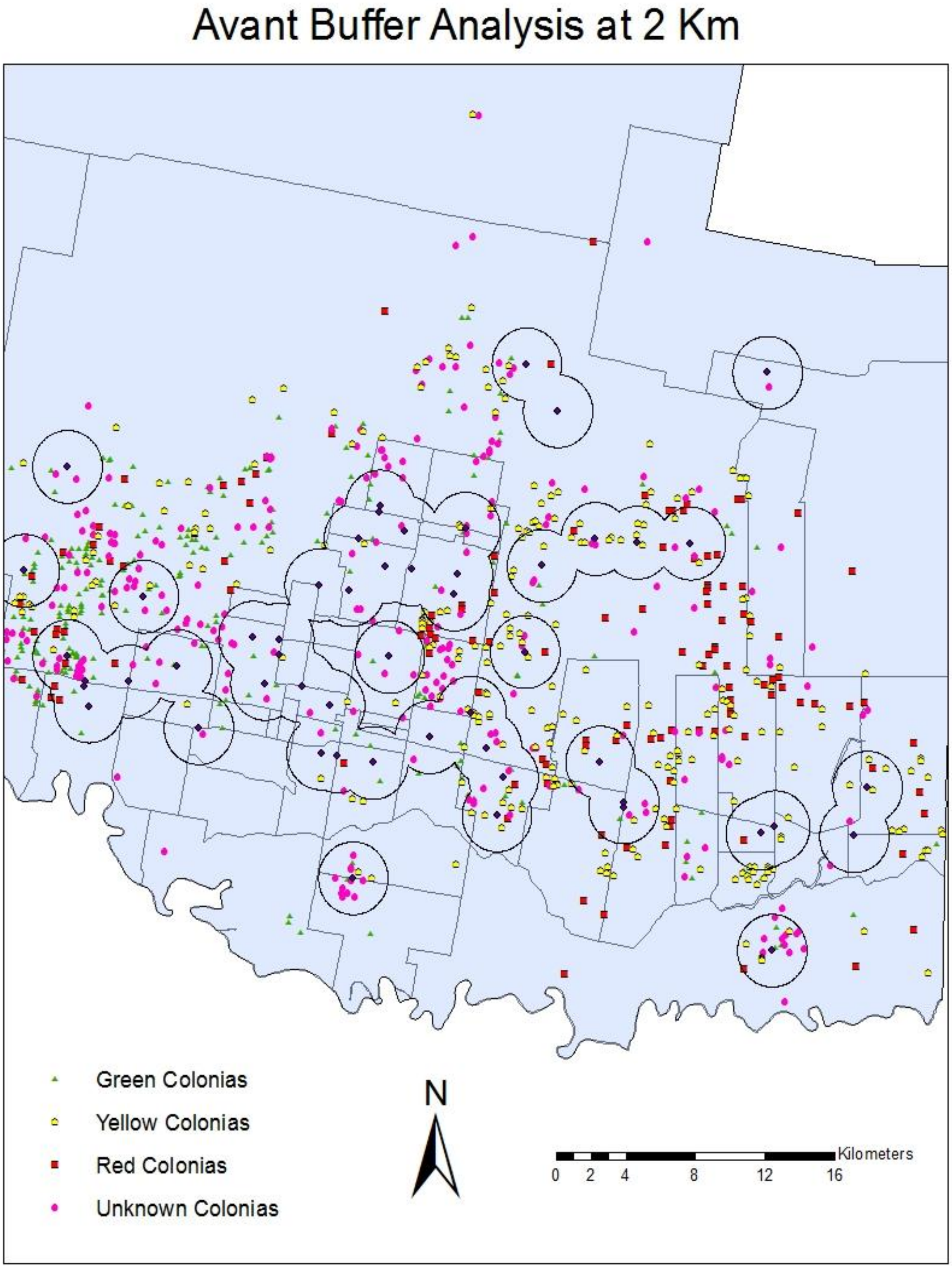

Figure 7: Avant buffer analysis at 2 kilometers

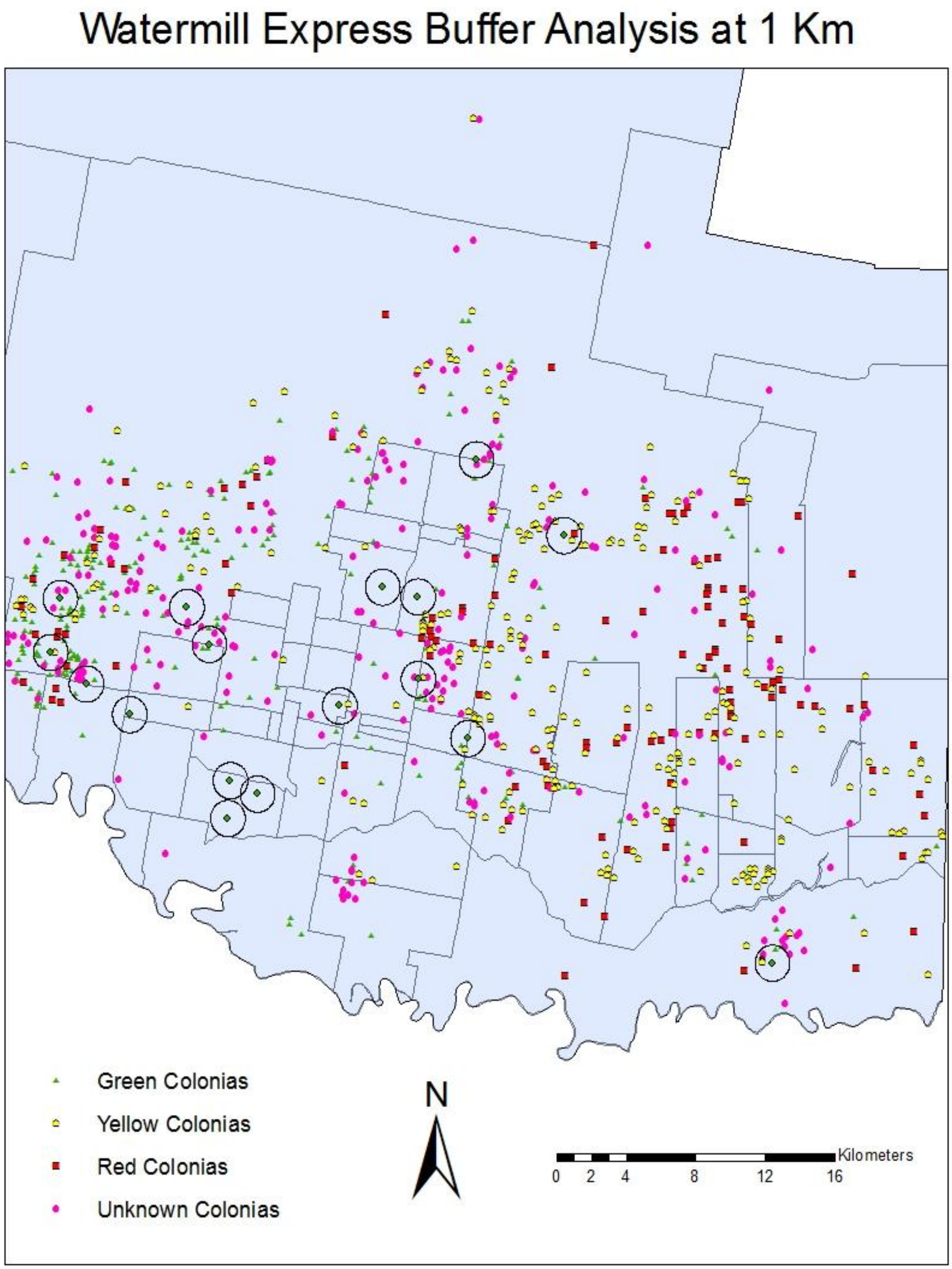

Figure 8: Watermill Express buffer analysis at 1 kilometer

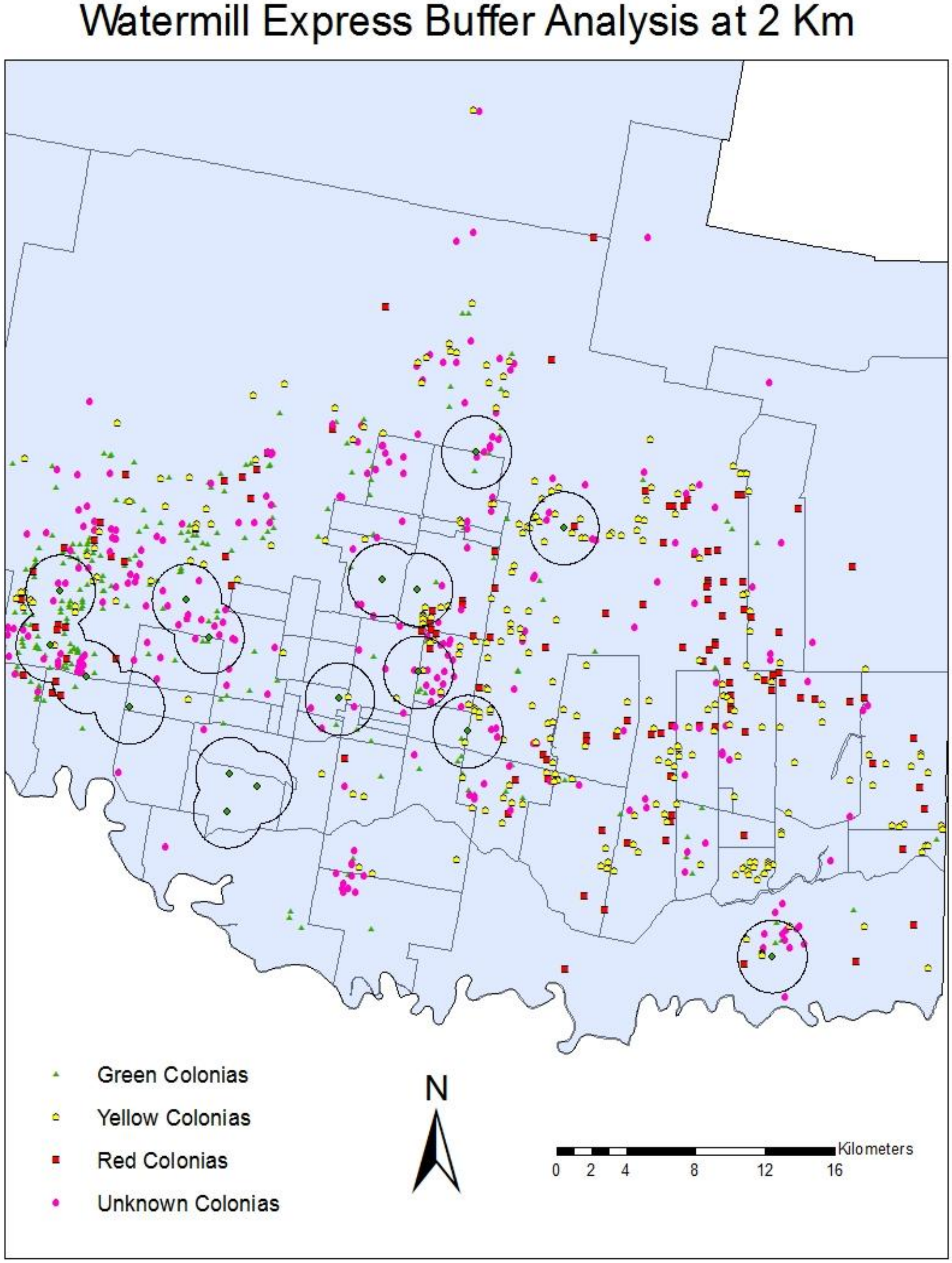

Figure 9: Watermill Express buffer analysis at 2 kilometers

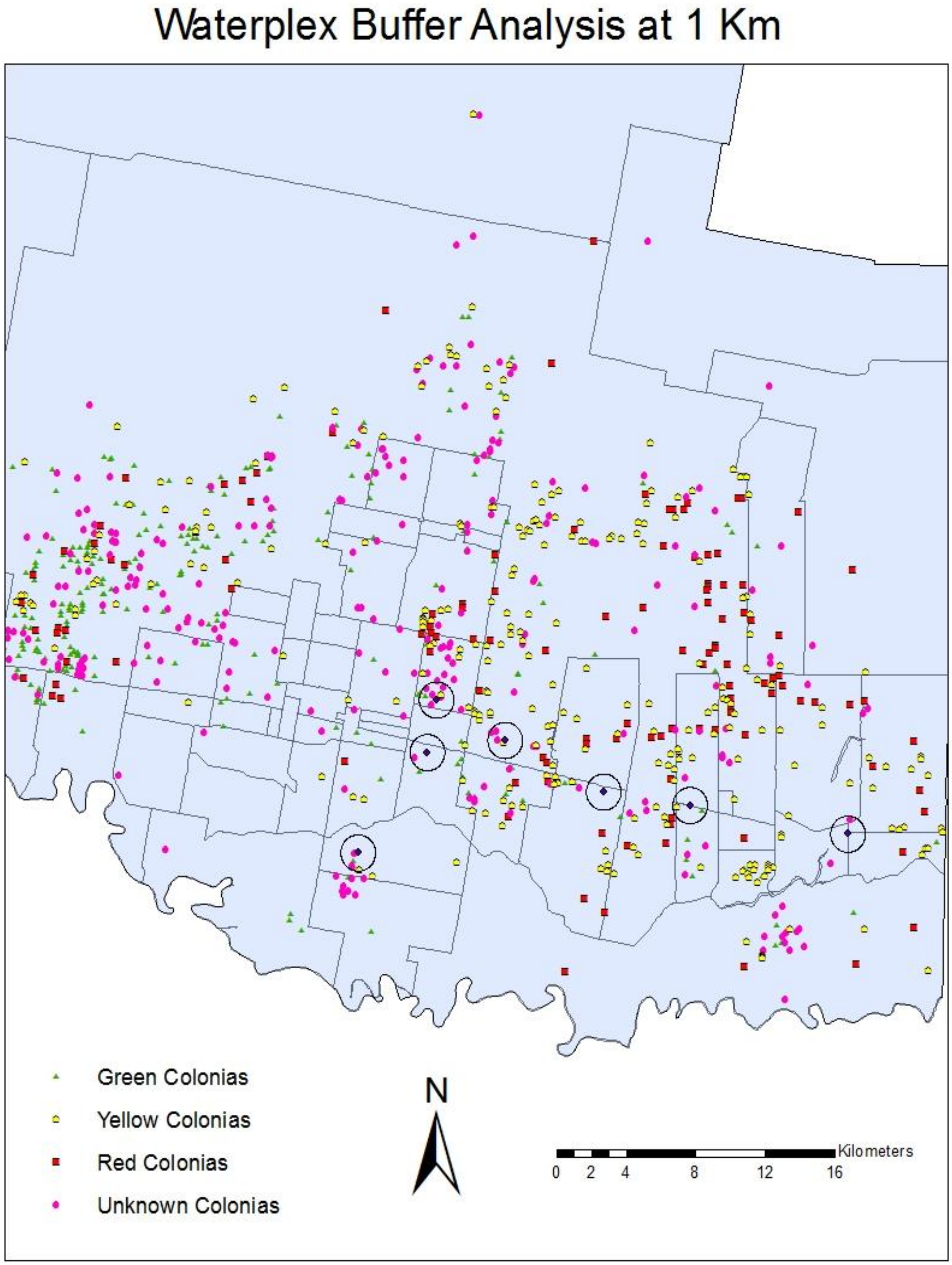

Figure 10: Waterplex buffer analysis at 1 kilometer

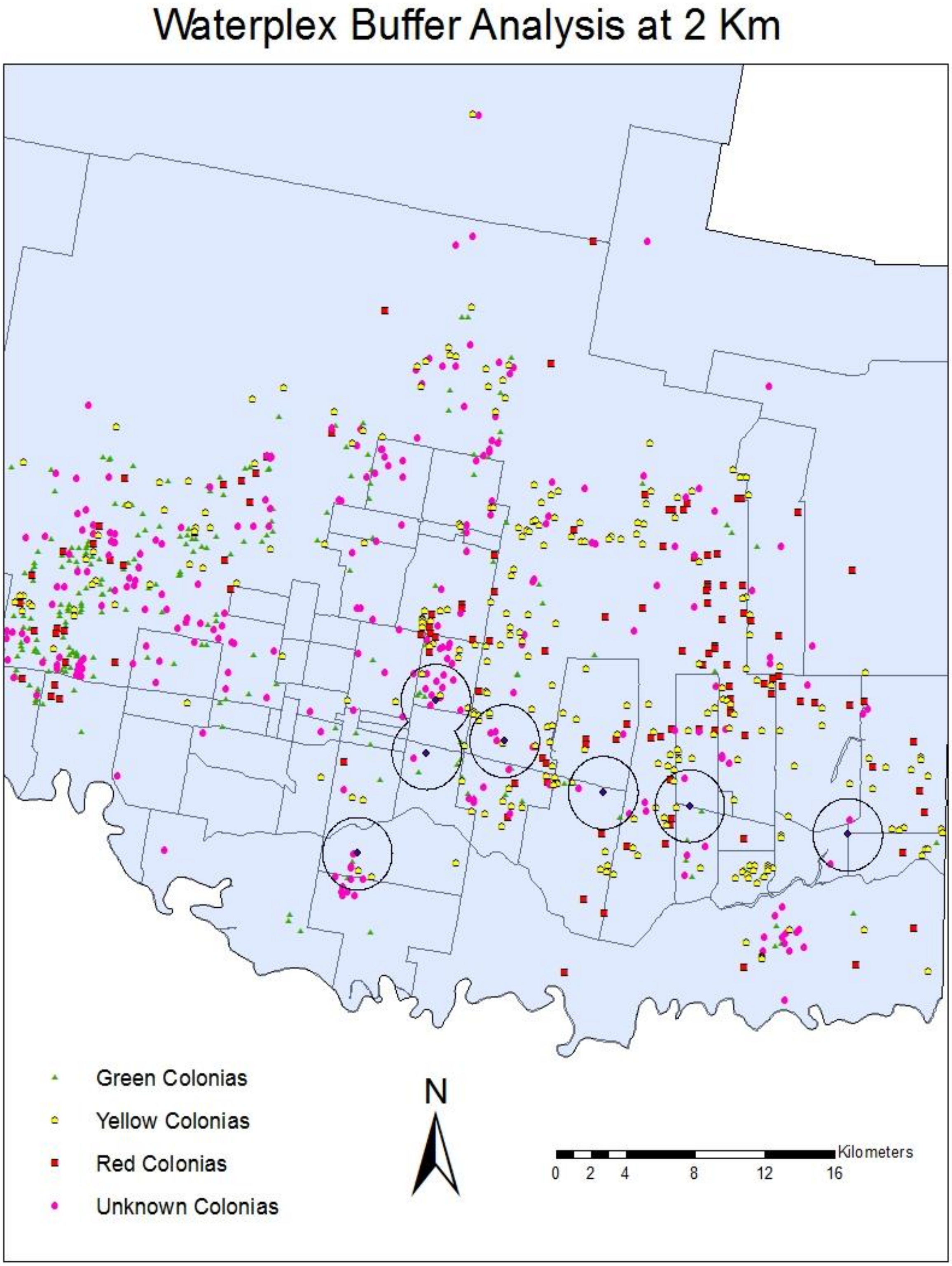

Figure 11 Waterplex buffer analysis at 2 kilometers

Table 3: Colonias inside the 1 kilometer buffers

1 Kilometer	Colonias	Aquamax	Avant	Watermill Express	Waterplex
	Green	0	37	20	4
	Yellow	0	35	8	4
	Red	0	8	2	0
	Unknown	0	51	24	14
Total		0	131	52	22

Table 4: Colonias inside the 2 kilometer buffers

2 Kilometers	Colonias	Aquamax	Avant	Watermill Express	Waterplex
	Green	1	84	81	13
	Yellow	1	82	42	16
	Red	0	31	13	3
	Unknown	1	110	69	30
Total		3	307	205	62

Table 5: Pearson correlation between colonia's and water vendors at 1 Km

1 Kilometer	Colonias	Aquamax	Avant	Watermill Express	Waterplex	Total
	Green	1	0.940308543	0.95715503	0.976785498	0.98214714
	Yellow	0.940308543	1	0.99215291	0.96419567	0.984672242
	Red	0.95715503	0.99215291	1	0.954148723	0.982987723
	Unknown	0.976785498	0.96419567	0.954148723	1	0.992775738
Total		0.98214714	0.984672242	0.982987723	0.992775738	1

Table 6: Pearson correlation between colonias and water vendors at 2 Km

2 Kilometers	Colonias	Aquamax	Avant	Watermill	Waterplex	Total
	Green	1	0.897119703	0.865125828	0.933328305	0.958745024
	Yellow	0.897119703	1	0.993964633	0.990805757	0.985324951
	Red	0.865125828	0.993964633	1	0.970476358	0.967193081
	Unknown	0.933328305	0.990805757	0.970476358	1	0.995272911
Total		0.958745024	0.985324951	0.967193081	0.995272911	1

Tables 3 and 4 depict the final total of colonias that appeared inside the 1 kilometer and 2 kilometer buffer zones. Tables 5 and 6 above show the correlation between colonias and water vendor businesses. By using Pearson correlation, our results include high numerical values, as the colonia's were the independent variable, and water vendors became the dependent variable. The numerical figures hardly stray from high positive figures close to one, meaning there is a great correlation between these two variables.

CHAPTER IV

DISCUSSION

Through the manipulate of the data sets in conjunction with levels of water security in the colonia regions of Hidalgo County we were able to assess why water companies place individual vending sites in their exact location. In addition, we compared the census data to the colonia regions and the water vending companies. We were able to accomplish this with the utilization of the ArcGIS program and create several maps using census data with different demographic variables.

Through family concentrations, our map demonstrates how high volume of family concentrations leads to larger colonia's with higher issues regarding water security. This can be attributed Hidalgo Counties' past history concerning poverty levels and an actual family's size and contribution towards household income. In terms of family income, each water company, with the exception of Aquamax, contains water distribution sites concentrated within regions of lower family income. Each company uses a certain distance to place multiple water distribution sites in areas of the lowest economic income as can been seen through the 2 kilometer buffer. When family income is compared to the colonia locations, there is a connection between those two features and high levels of water security. In regards to accessible transportation in Hidalgo County, there is a trend following each shaded area in the different levels of vehicles per household. Each shaded region continues to have about the same level of accessible transportation as it moves up from 0 to 4 vehicles per household. Although this may be true, one must review a household's family population and its available income. Other factors that were not investigated through this research, such as type and price of vehicle, need to be taken into consideration. When compared to the locations of water vendor sites, there is a strong correlation towards Avant, Waterplex, and Watermill Express since each business buffer region in their main region of placement overlaps a high level of access to transportation. Looking at the higher levels of transportation accessibility, there looks to be a lack of water vendor businesses. Interestingly, single water vendor sites can be located in the higher level of transportation accessibility region, which is only centered on a colonia position. We can infer that water vendors take into account population's transportation availability and place multiple businesses for accessibility and higher profit. Opposite from the trends following the accessibility of transportation, education levels differ from high school to college education. Areas that encompass a high level of water security decrease in numbers as it jumps from high school education to college education levels. This decrease in numbers can be attributed to Hidalgo County's lack of advancement in higher education due to financial or family circumstances. Further investigation into this topic can yield additional responses. Again, these two maps differ from each other. In comparison, bottled water businesses have a similar connection with other census data maps. Within each company's buffer regions, excluding Aquamax, an area of low education levels is included. This can be inferred as a possible factor in which water vending sites can be placed since low education levels often lead to low income populations.

In regards to our statistical analysis, there is hardly any change from the higher numerical values as seen from Table 5. Values stay close to one, showing a positive correlation between colonia’s and water vendors. This can infer that water vendors use locations of colonia’s as a means of placing their businesses for the highest yield in profit.

CHAPTER V

CONCLUSION

The background information found in our first chapter of our thesis studied the history of the commodification of bottled water and how it is seen in today's society, including the perceptions of water quality and technological advances. Our next chapter focused on the quantitative aspect of our research that relied heavily on the mapping system in GIS. Following Chapter II. our results entailed obtaining our analyzed data, leading to a discussion with comparisons with all data sets and response to locations of bottled water sites.

The Lower Rio Grande Valley has faced problems with water security for many years. In doing so, bottled water industries have moved into the area to provide a service of water commodification, or in their terms, "safe, drinking water". By investigating past census data and targeting colonia's with low water security, bottled water vendors have been able to yield large amounts of profit. Through education programs, dependable infrastructure in households, and more, citizens of the lower Rio Grande Valley can overturn their addiction to bottled water and rightfully gain back their security in water.

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APPENDIX

Table 7: Avant locations

Avant			
#	Address	City	Associated Business
1	Durante and Alamo Rd	Alamo	
2	El Gato Rd and South Tower Rd	Alamo	
3	626 N Cesar Chavez Rd	Alamo	Murphy USA
4	713 South Tower Rd	Alamo	Cavazo's Drive-Thru
5	South Salinas and South Ave	Donna	
6	12203 N. FM 493	Donna	Garcia’s Tortilleria
7	1009 Highway 83	Donna	Stripes Convenient Store
8	West Sprague and 4th	Edinburg	
9	West University and Jackson	Edinburg	
10	Owassa and Tower	Edinburg	San Marcos Country Store
11	1318 S. Tower Rd	Edinburg	Tortilleria Fiesta
12	2563 S. Raul Longoria	Edinburg	Ducky's Carwash
13	2800 S Closner	Edinburg	Fiesta Foods
14	Terry & Ramseyer Rd	Edinburg	El Tendajo
15	Trenton and McColl	Edinburg	Walmart/Murphy USA
16	8405 E. Harrah Drive	Edinburg	DeAlba Bakery
17	3509 S. Raul Longoria	Edinburg	Stripes Convenient Store
18	2626 S. Sugar Rd.	Edinburg	Stripes Convenient Store
19	9224 E. Highway 107	Edinburg	Stripes Convenient Store
20	4420 W. University	Edinburg	Stripes Convenient Store
21	2824 E. Freddy Gonzalez	Edinburg	Stripes Convenient Store
22	2504 E. University	Edinburg	Stripes Convenient Store
23	Mile 6 West and Hwy 107	Elsa	Stripes Convenient Store
24	Highway 88 & Mile 15	Elsa	Sunrise Grocery
25	McColl Road and Hackberry	McAllen	
26	North 23rd and Daffodil	McAllen	
27	4001 N. 23rd	McAllen	Walmart
28	Pecan and 27th	McAllen	Pecan Plaza
29	7300 N. 10th	McAllen	Tejano Mart
30	620 E. Ridge Rd	McAllen	Tejano Mart
31	10th and Pecan	McAllen	Tejano Mart
32	3901 North Ware Rd.	McAllen	Stripes Convenient Store
33	South Conway and Ramirez	Mission	
34	Inspiration and Business 83	Mission	
35	7 Mile Line and Minnesota	Mission	

36	1700 E. Griffin Parkway	Mission	
37	2416 E. Expressway 83	Mission	Walmart/Murphy USA
38	520 Inspiration	Mission	Stripes Convenient Store
39	5500 West 7 Mile Rd	Mission	Stripes Convenient Store
40	4500 N. Conway Ave	Palmhurst	Walmart/Murphy USA
41	Hwy 281 and FM 3072	Pharr	Las Milpas
42	Cage and Ridge Rd	Pharr	Wonder Store
43	1521 W. Ridge Rd	Pharr	Stripes Convenient Store
44	Nebraska and 1st	San Juan	
45	101 W. Nolana Loop	San Juan	Stripes Convenient Store
46	2005 Palm Vista Drive	Palmview	Stripes Convenient Store
47	2900 West 3 Mile Line	Palmview	Stripes Convenient Store
48	Business 83 and Texas Ave	Mercedes	
49	16506 E. Indian Hills	Mercedes	
50	25161 FM 88	Monte Alto	
51	FM 1015 & Palm Drive	Progreso	Red Ant Mart
52	1015 and 11 Mile Road	Weslaco	
53	2424 E. Business 83	Weslaco	Moreno's Feed

Table 8: Watermill Express locations

Watermill Express			
#	Address	City	Associated Business
54	6715 E State Highway 107	Edinburg	
55	W Fm 1925	Edinburg	
56	4120 S US Highway 281	Edinburg	
57	3511 S Sugar Rd	Edinburg	Car Wash
58	4112 S Ware Rd	McAllen	Laundromat/Car Wash
59	1309 E Jasmine Ave	McAllen	
60	4600 S 23rd St	McAllen	Stripes Convenient Store
61	2107 W Expressway 83	Mission	Exxon Gas Station
62	3301 N Shary Rd	Mission	Exxon Gas Station
63	105 S Bentsen Palm Dr	Mission	
64	3601 E Military Hwy, Mission	Mission	
65	1901 W 3 Mile Rd	Mission	
66	213 E Expressway 83	Mission	
67	Palm & Expressway 83	Mission	
68	3609 N I Rd	Pharr	Stripes Convenient Store
69	501 N Cesar Chavez	San Juan	Exxon Gas Station

70	815 W Highway 281	Weslaco	

Table 9: Waterplex locations

Waterplex			
#	Address	City	Associated Business
71	1115 Frontage Rd	Alamo	
72	231 S 8th St	Donna	
73	736 W 2nd St	Mercedes	
74	5910 S Hwy 281	Pharr	
75	111 W 9th St	San Juan	
76	1805 N Raul Longoria Rd	San Juan	
77	113 S Westgate Dr	Weslaco	

Table 10: Aquamax locations

Aquamax			
#	Address	City	Associated Business
78	1624 N 10th St Ste. 7	McAllen	
79	525 W Nolana Ave	McAllen	

Maps of selected demographic variables

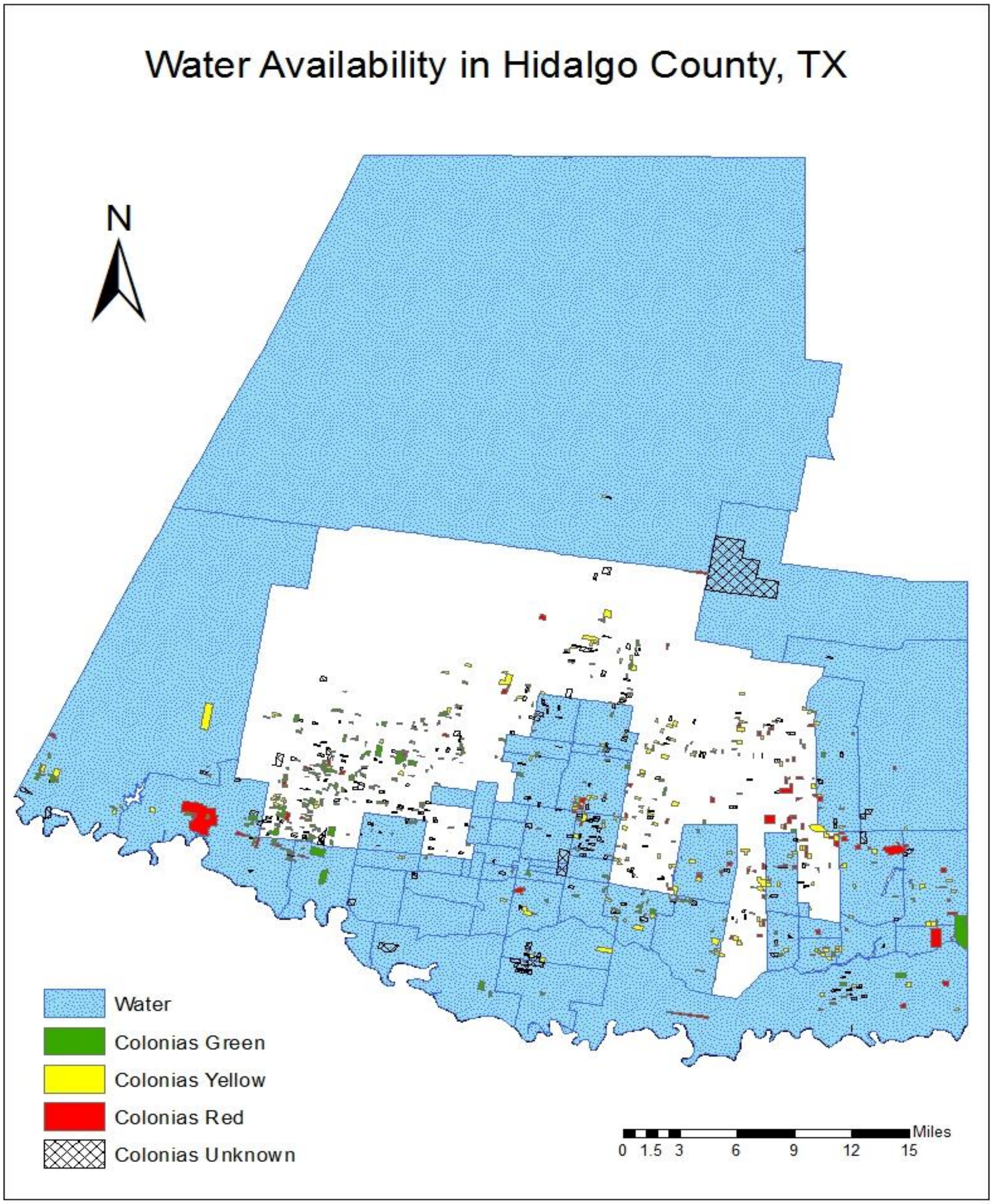

Figure 12: Water availability in Hidalgo County

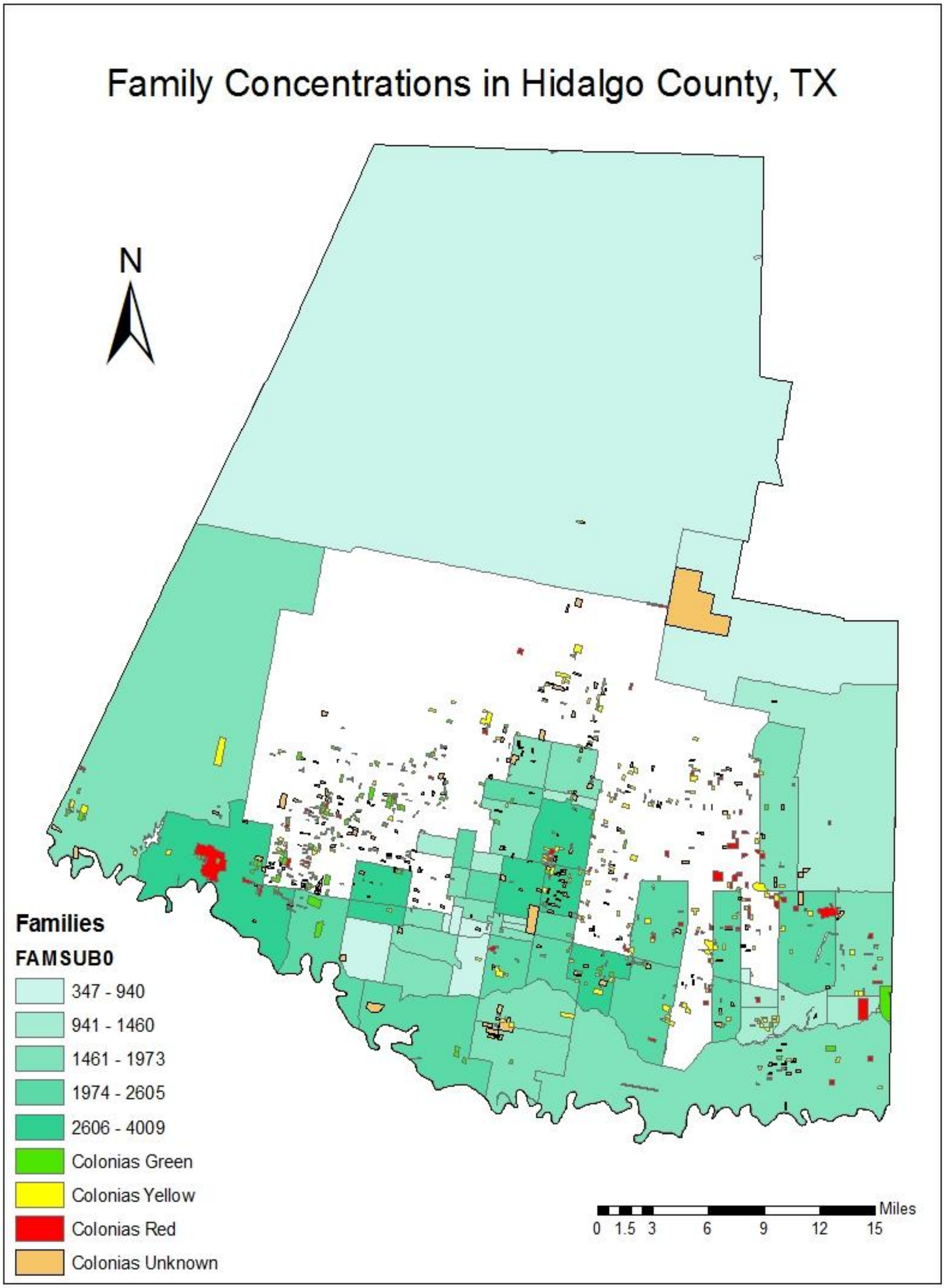

Figure 13: Family concentrations in Hidalgo County, TX

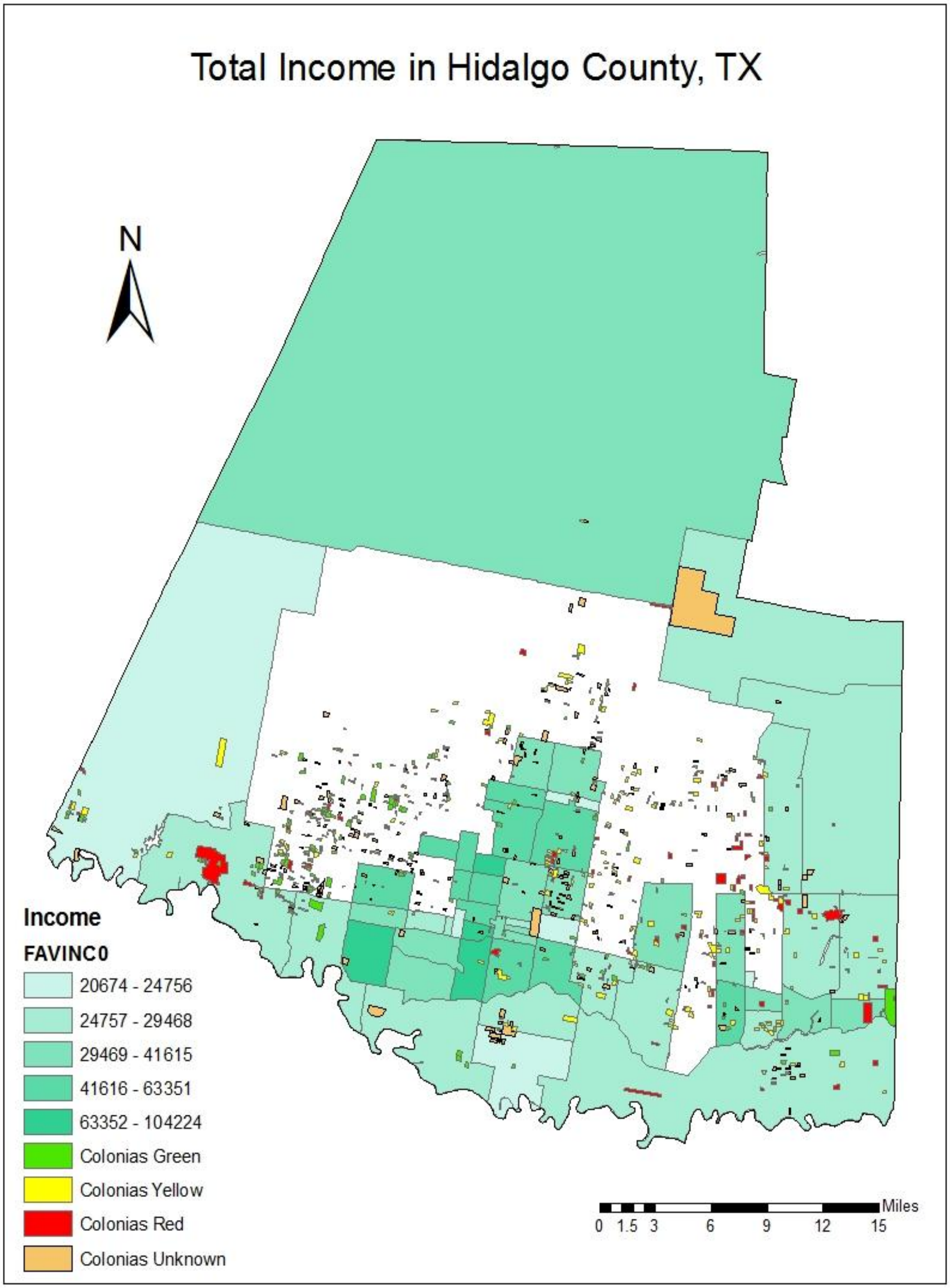

Figure 14: Total family income in Hidalgo County, TX

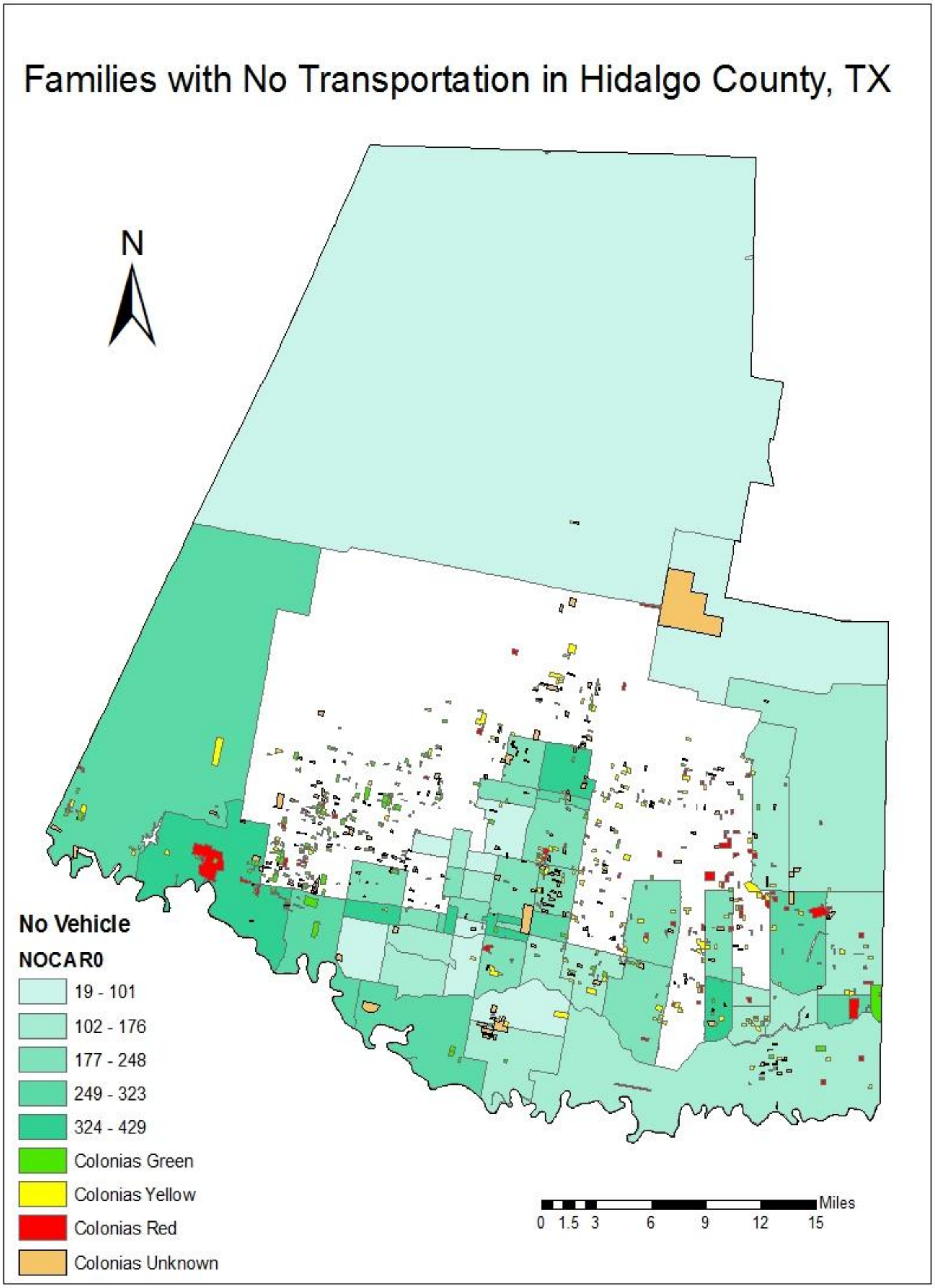

Figure 15: Families with no transportation in Hidalgo County, TX

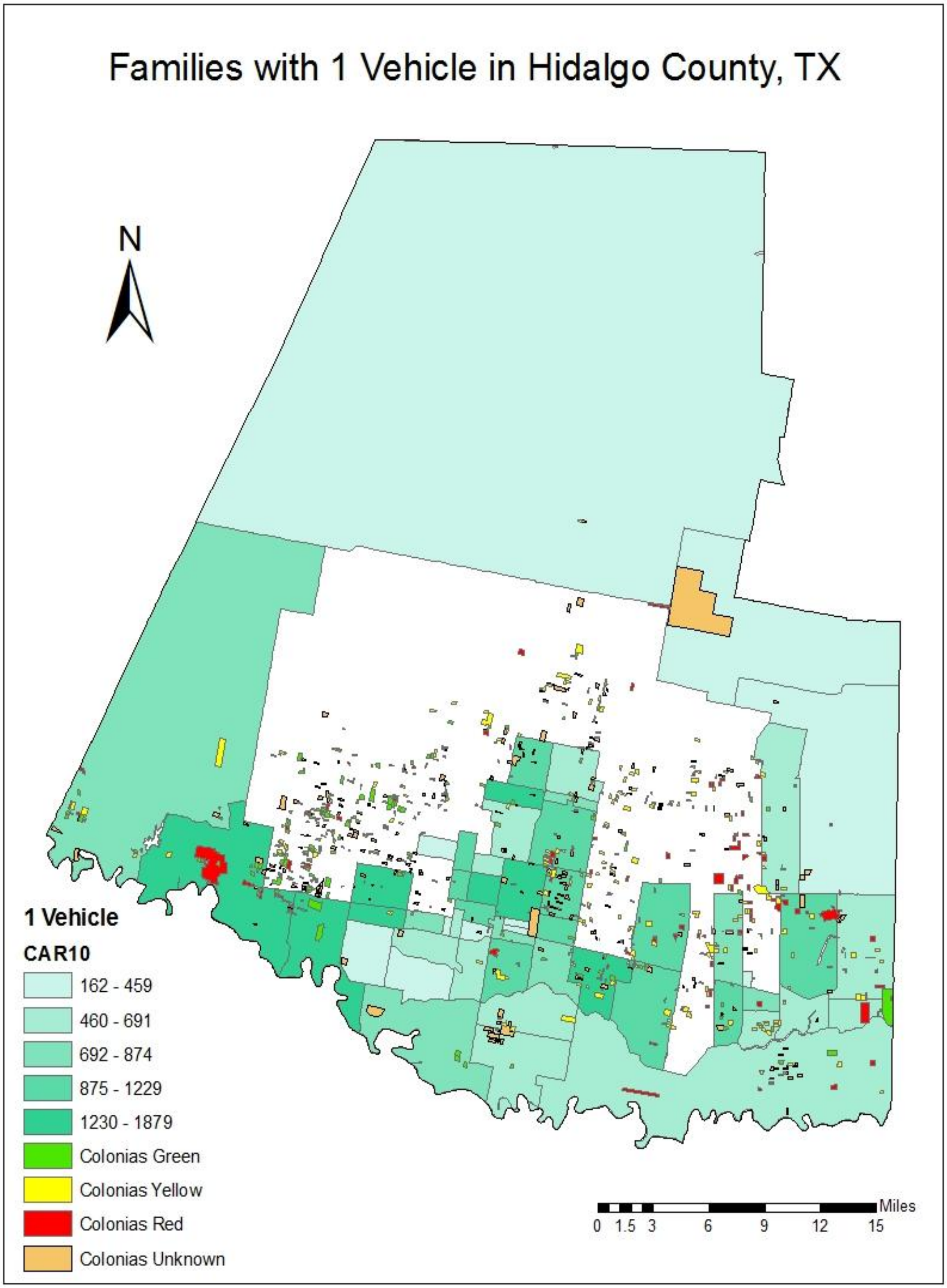

Figure 16: Families with 1 vehicle in Hidalgo County, TX

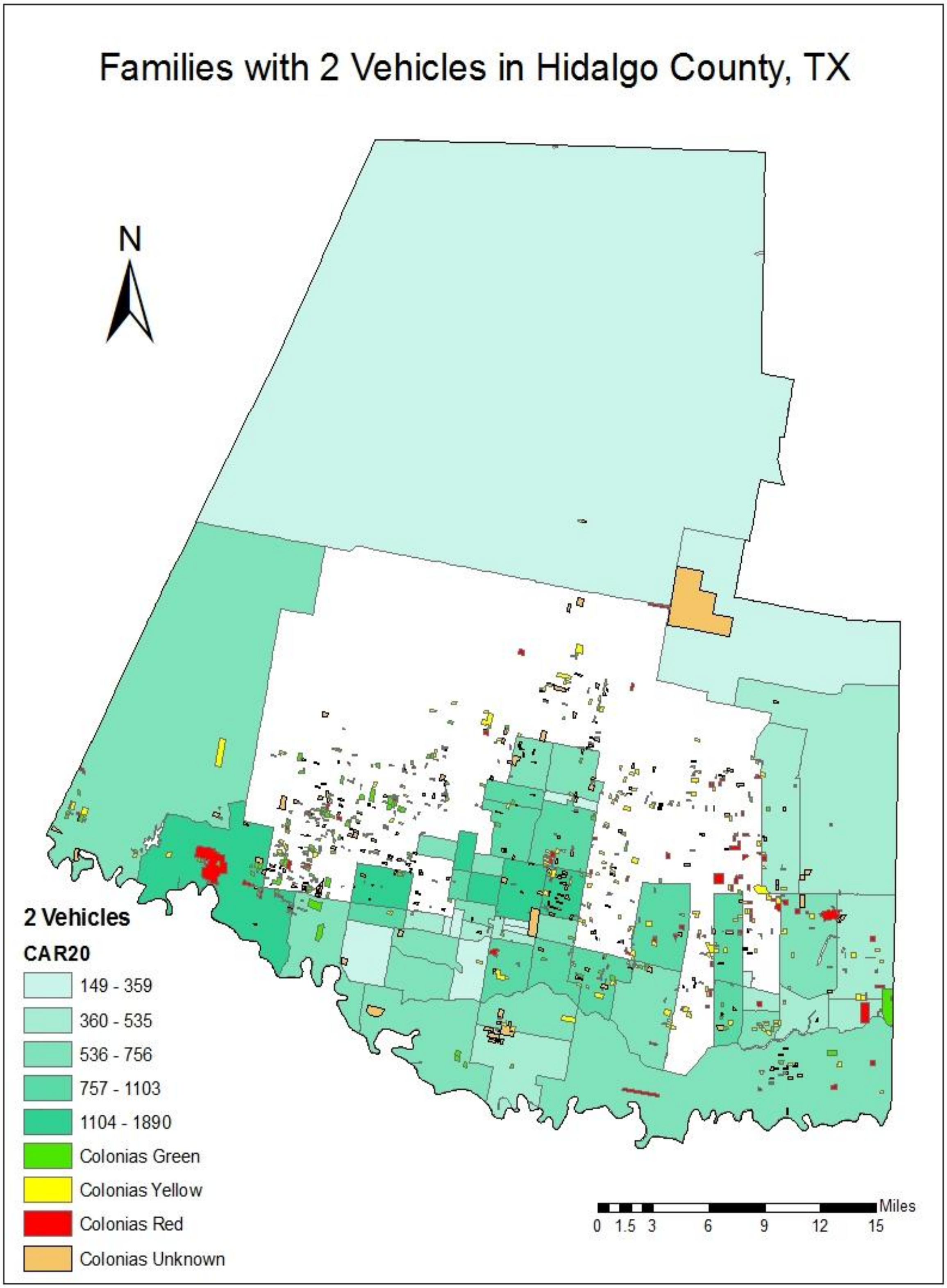

Figure 17: Families with 2 vehicles in Hidalgo County, TX

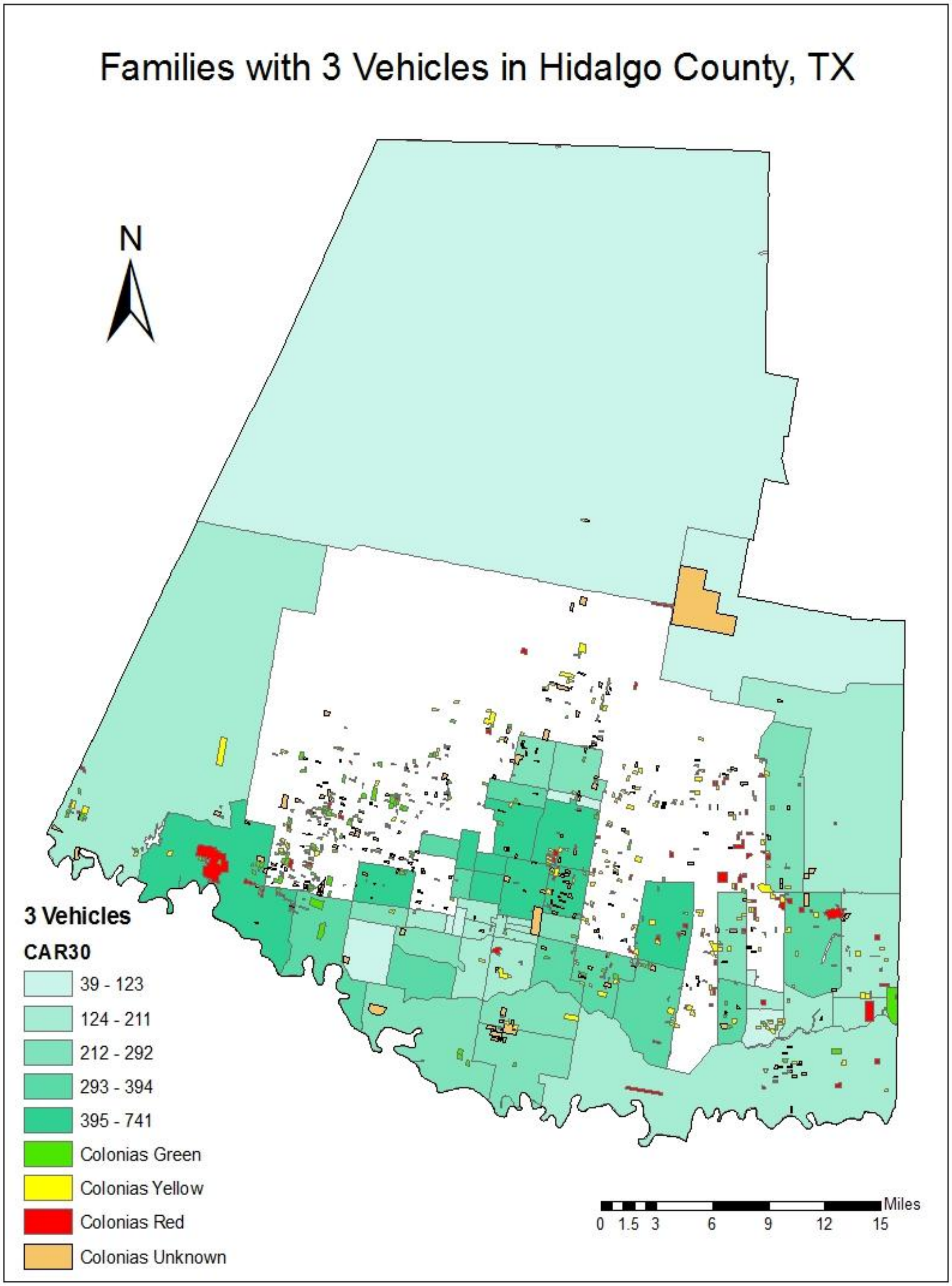

Figure 18: Families with 3 vehicles in Hidalgo County, TX

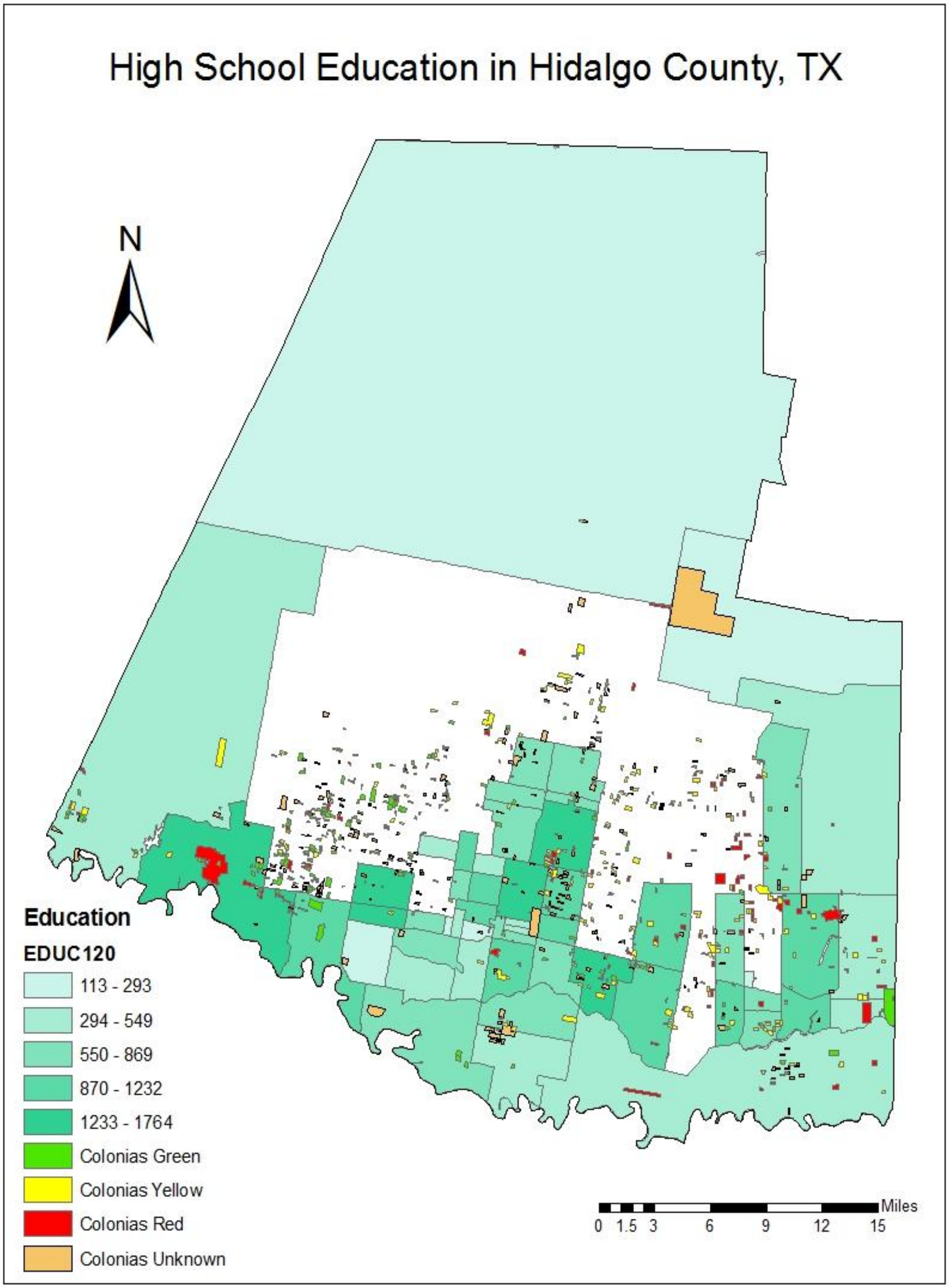

Figure 19: Individuals with high school education in Hidalgo County, TX

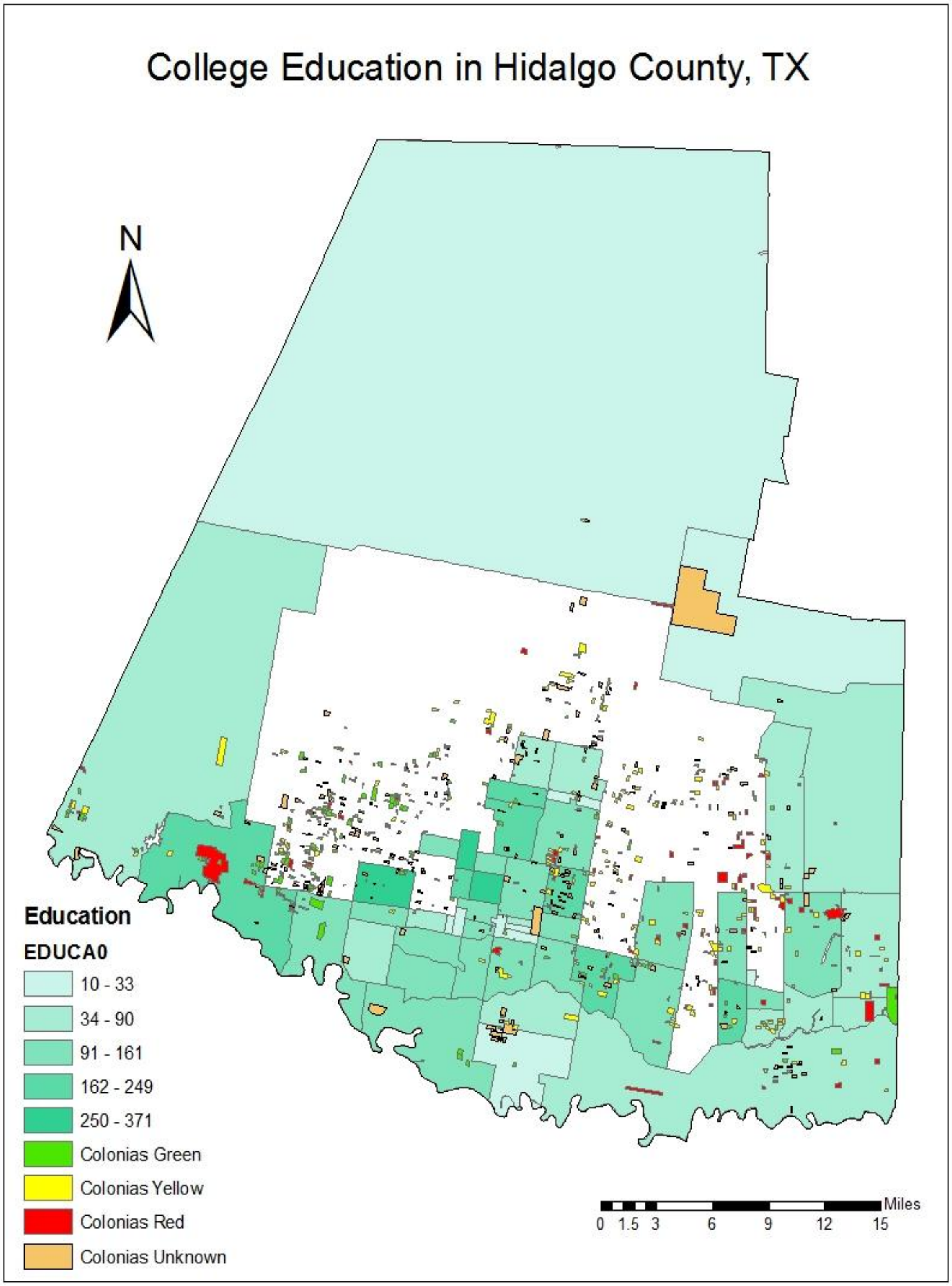

Figure 20: Individuals with college education in Hidalgo County, TX

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