Flood Risk Areas in El Paso County, Texas

William Delgado

C E 394K
Dr. David R. Maidment
Dr. David G. Tarboton
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Introduction

El Paso County is located in the westernmost part of Texas adjacent to the Mexican state of Chihuahua and Doña Ana County, New Mexico (City of El Paso, 2016). El Paso City is the county's primary population center and economic hub, home to 630,000 of the county's 730,000 residents according to 2006 estimates (ibid). El Paso City, whose name in Spanish means 'The Pass," is situated at an average elevation of 4,000 ft. (1200 m) above sea level between the Franklin Mountains to the north and the Juarez Mountains to the south. The Franklin Mountains split El Paso City into an east side and a west side. The Rio Grande forms the US-Mexico Border at bottom of the basin between the two mountain ranges and divides El Paso City from its sister city, Ciudad Juarez (City of El Paso, 2016).

El Paso County has an arid climate with approximately 300 days of sunshine per year and an average annual rainfall of only 8.65 inches (City of El Paso, 2016). However, torrential rains occasionally strike El Paso County causing widespread damage. For example, in late July and early August 2006, a series of storms pummeled El Paso County with heavy rains. During this event, a year's worth of precipitation fell in two days causing $200 million in damages to businesses and $115 million in damages to El Paso City's storm water infrastructure (El Paso Water, n.d.). The International Boundary and Water Commission estimated that the storms caused $286 million in damages to Rio Grande flood control infrastructure (Michelsen, 2006). This essay will examine flood risk areas in El Paso County based on flood risk data from the Federal Emergency Management Agency (FEMA), topographical maps, and land cover change graphs. Given that El Paso County has a rapidly growing population with 23.4% of residents living below the poverty line, this essay will also use census block group median income data from the US Census Bureau to

illustrate the fact that many areas with high flood risks encompass low-income communities (US Census Bureau, 2014).

Methodology to Determine Flood Risk Areas

FEMA uses terminology from the National Flood Insurance Program (NFIP) to determine flood risk areas. 'Base flood' is a key term that serves as the baseline probability of a flood occurring in a given year (NFIP, n.d.). The baseline probability is a one-percent annual chance flood. A one-percent annual chance flood has a one percent chance of occurring in a given year. Another name for one-percent annual chance flood is 100-year flood (ibid). NFIP and other federal agencies use the 100-year flood probability as the national standard to regulate development and as the basis for requiring the purchase of flood insurance (NFIP, n.d.). Figure 1 below explains flood risk probabilities in greater detail.

WHAT ARE THE ODDS OF BEING FLOODED?

The term "100-year flood" has caused much confusion for people not familiar with statistics. Another way to look at flood risk is to think of the odds that a 100-year flood will happen sometime during the life of a 30-year mortgage—a 26% chance for a structure located in the SFHA.

Chance of Flooding over a Period of Years

Time Period	Flood Size 10-year	25-year	50-year	100-year
1 year	10%	4%	2%	1%
10 years	65%	34%	18%	10%
20 years	88%	56%	33%	18%
30 years	96%	71%	45%	26%
50 years	99%	87%	64%	39%

Even these numbers do not convey the true flood risk because they focus on the larger, less frequent, floods. If a house is low enough, it may be subject to the 10- or 25-year flood. During a 30-year mortgage, it may have a 26% chance of being hit by the 100-year flood, but the odds are 96% (nearly guaranteed) that it will be hit by a 10-year flood. Compare those odds to the only 1-2% chance that the house will catch fire during the same 30-year mortgage.
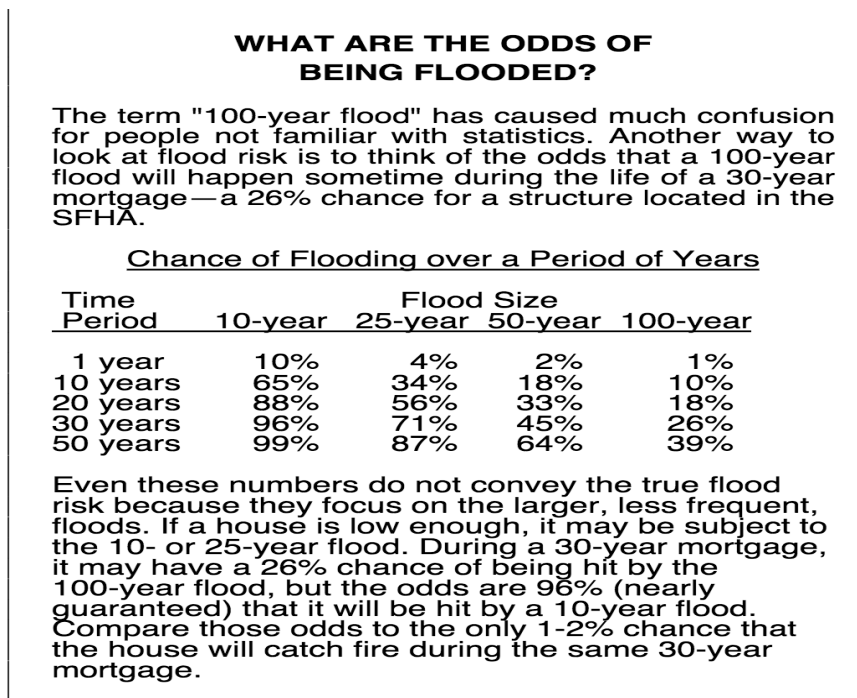
Figure 1: Explanation of flood probabilities (NFIP, n.d.)

The NFIP calls flood prone areas special flood hazard areas (SFHAs). Base flood elevations are the anticipated levels in SFHAs to which floodwaters are expected to rise during base floods (NFIP, n.d.). Property owners located in SFHAs are required to purchase flood insurance (ibid). Today, FEMA is responsible for implementing the mandates from the National Flood Insurance Act of 1968 (NFIA) that call for identifying flood prone areas across the United States and establishing flood risk zones in flood prone areas (NFIP, n.d.). FEMA uses factors such as soil profiles, previous high water marks, aerial photographs of past floods, and topographic maps to outline flood prone areas and the flood risk zones within those areas (ibid).

FEMA executes its mandates from the NFIA by publishing Flood Insurance Study (FIS) reports and Flood Insurance Rate Maps (FIRMs) (NFIP, n.d.). FIRMs and FIS reports have a pivotal role in helping communities adopt effective flood management measures (ibid). FIS reports were designed for rapidly growing heavily urban communities, and are therefore particularly important for El Paso County (NFIP, n.d.). In addition to providing more details on FIRMs, FIS reports focus on flood mitigation policies for new construction in urban and urbanizing areas (ibid). FIS reports are the basis for setting flood insurance rates and SFHA management policies (NFIP, n.d.). FIS reports contain a FIRM and a study description that includes a summary of historic floods, areas and flooding sources studied, and engineering methods utilized. They also contain a map of the area surrounding the community, tables that summarize flood hazard data, and profiles for different flood recurrence probabilities such as the 10, 50, 100, and 500-year floods (ibid).

A, AE, and D are the key SFHA designations from FEMA FIRMs for El Paso County. The data come from 2005 FEMA Q3 FIS reports and do not reflect the growth that has

occurred in El Paso County in the past decade. AE zones are the basis for base flood

elevations in SFHAs (NFIP, n.d.). They mostly overlap with A zones in El Paso County (see

Figure 2b). A zones are areas in which 100 year-floods occur and homes have a 26%

chance of flooding over the course of a 30-year mortgage. A zones do not have base flood

elevations due to a lack of detailed analysis (ibid). However, the overlap of AE and A zones

in El Paso County means that most SFHAs will have base flood elevation data. Lastly, D

zones are SFHAs with possible but undetermined flood hazards due to the lack of

investigation of the area (NFIP, n.d.). Flood insurance rates for D zones reflect the

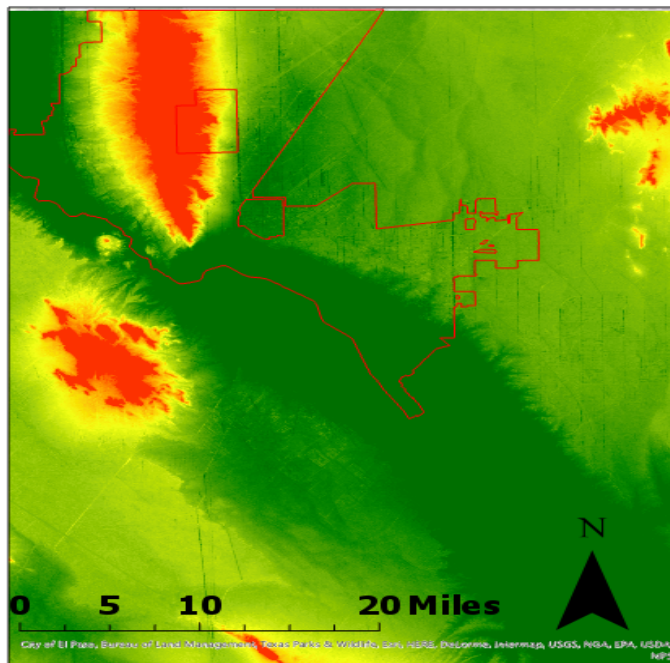uncertain flood risk (ibid).

Topography

Figure 2a (USGS, n.d.)

El Paso County, Texas Digital Elevation Model (meters)
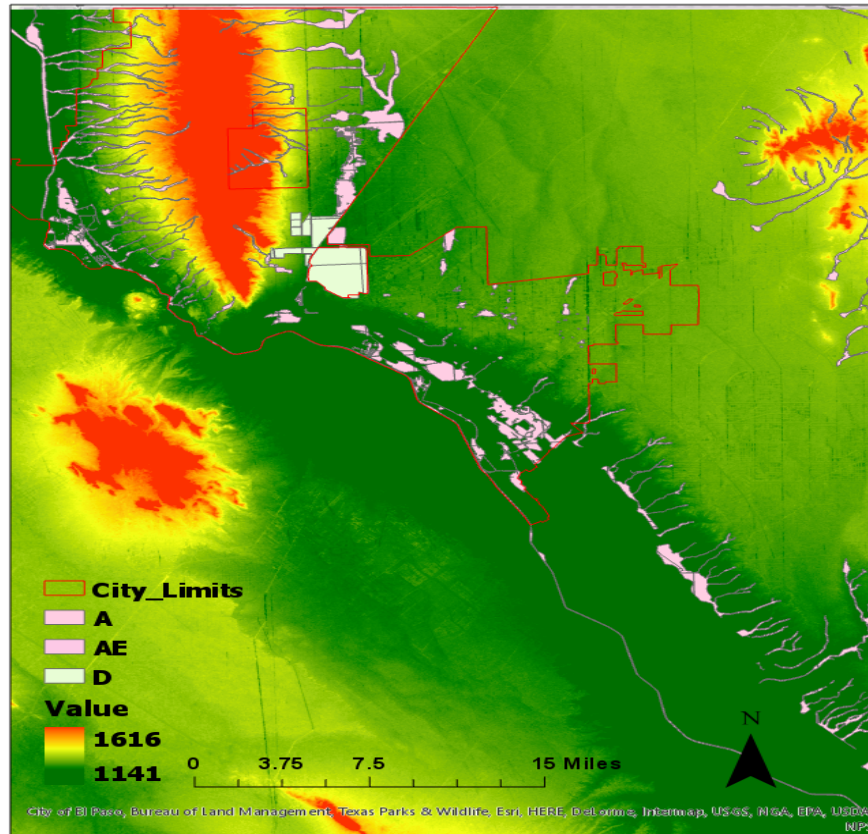### With Flood Risk Zones

Figure 2b (USGS, n.d.)

The mountainous parts of El Paso County contain many arroyos, canyons, creeks, and other drainage canals (City of El Paso, 2016). Some of these are illustrated as veins in the digital elevation model (DEM) above protruding down from the long red patch in the top left corner of the map and the smaller red patch in the top right corner. These patches represent the Franklin Mountains and the Hueco Mountains respectively. The red patch south of the Franklin Mountains represents the Juarez Mountains on the Mexican side of the Rio Grande.

It is unsurprising that arroyos that extend down from the main mountain ranges in El Paso County are considered A SFHA areas according to FEMA (see figure 2b). The rapid and abrupt elevation changes between the mountains and the valley floor causes water from rain events to flow at high speeds, which in turn creates ephemeral waterfalls that are really hazardous to vehicles and pedestrians. Natural debris such as boulders obstructs water flow creating an opportunity for water to pile up and flow over arroyo banks. Human debris such as old tires and furniture also causes this type of event (Viesca-Santos, 2007). Images 1 and 2 below demonstrate that human debris is a real problem for arroyos in El Paso County. Image 2 is a picture of evidence used to sentence an El Paso trucking company owner who was found guilty of illegally dumping construction waste into an arroyo (ibid). Given that El Paso County's population is increasing quickly, management of debris in arroyos will become more imperative to control flooding from rain events.

Image 1: Illegal dumping El Paso County (Schoenemann, 2016)

Image 2: Evidence of Trujillo Trucking Company illegal dumping (Viesca-Santos, 2007)

The majority of El Paso County's A SFHA zones are positioned at the low-lying base of the east and west sides of the Franklin Mountains or the lowest part of the Rio Grande Depression in the southeast part of El Paso City and El Paso County (see figure 2b). The A SFHA zones in the southeastern part of the Rio Grande Depression probably exist because they drain small arroyos that originate from slightly higher territory to the northeast. These zones also process large amounts of river water from northwest El Paso City and further upstream in New Mexico and Colorado. This could be another explanatory factor for the formation of A SFHA zones in this area.

The A SFHA zones on the west side of the Franklin Mountains are located in logical areas for these types of zones for two reasons. First, they are situated in the lowest-lying part of the immediate vicinity and are therefore the first place running water will seek. Secondly, their location at the base of a much higher mountain provides a reasonable location for water flowing down mountain arroyos to accumulate. The fact that these zones are at the end of the mountain arroyos in figure 2b provides evidence for this idea.

Land Cover Trends

The A SFHA zones at the base of the east side of the Franklin Mountains (see figure 2b) are also located appropriately at the bottom of an area with highly fluctuating elevations. But, they are wider than their counterparts on the west side. This could be due to swift land cover changes due to rapid growth at Fort Bliss Army Post in northeast El Paso City (City of El Paso, 2016). Figures 3a, 3b, and 3c on pages 10, 11, and 12 respectively provide evidence of brisk land cover changes in this area. They also show that land cover is much more extensively developed on the east side. Furthermore, the much smaller A SFHA zones at the base of the Hueco Mountains, a significantly less urbanized

area (see figures 3a, 3b, and 3c), also suggest that land cover could be a key factor in the size of A SFHA zones. However, figures 3b and 3c also indicate brisk land cover changes on the west side of the Franklin Mountains. Therefore, it is possible that soil types play a part in determining water absorption levels and thus A SFHA zones. Due to the presence of the Rio Grande, soils on the west side of the Franklin Mountains are likely to be more riparian and hence able to absorb water more easily. In contrast, the east side of the Franklin Mountains lacks a large riparian zone, which may cause soils there to absorb water less easily and contribute to larger A SFHA zones.
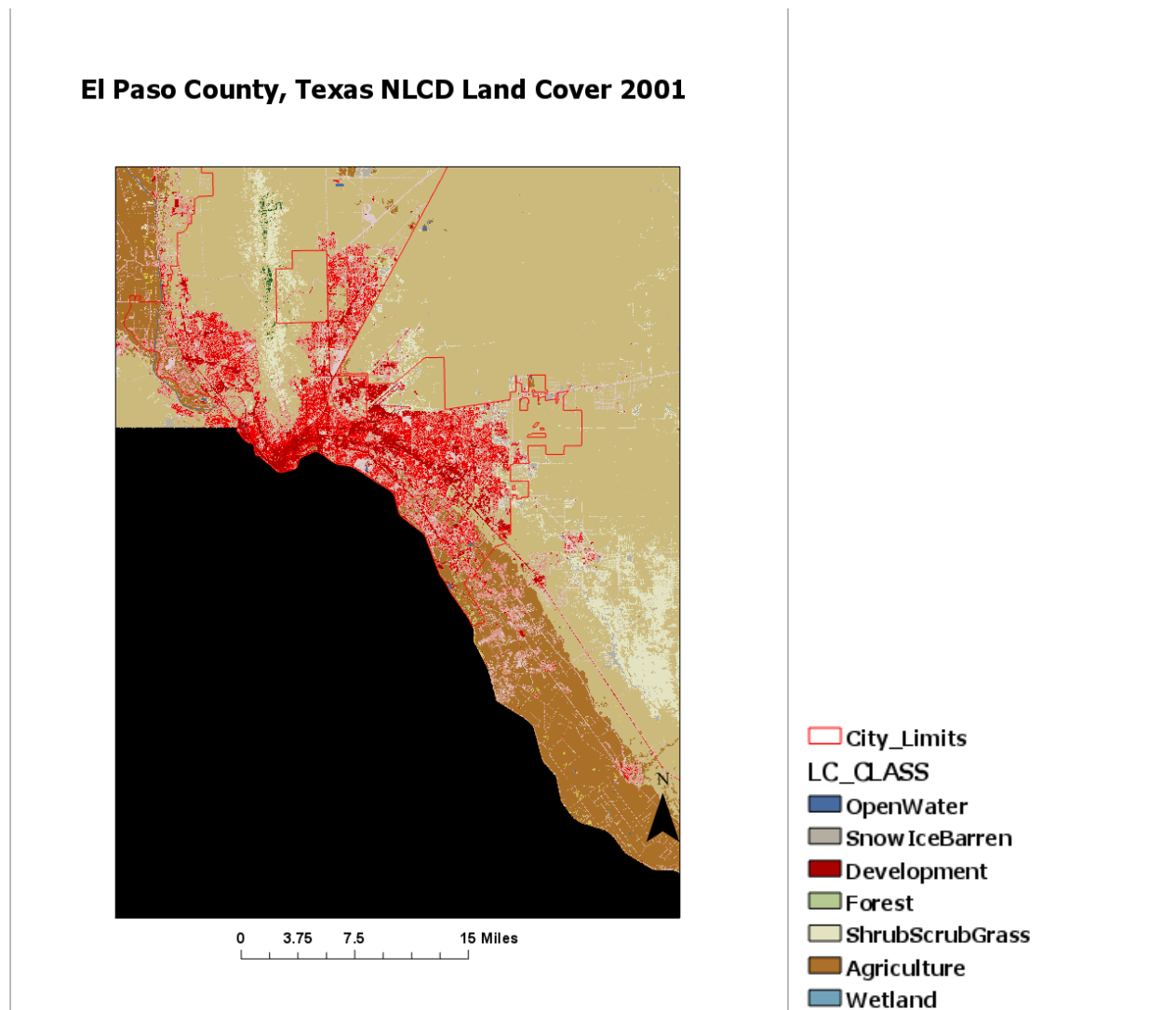

Figure 3a (MRLC, n.d.)

El Paso County, Texas NLCD Land Cover 2006

Legend:

City_Limits
LC_CLASS
OpenWater
Snow IceBarren
Development
Forest
ShrubScrubGrass
Agriculture
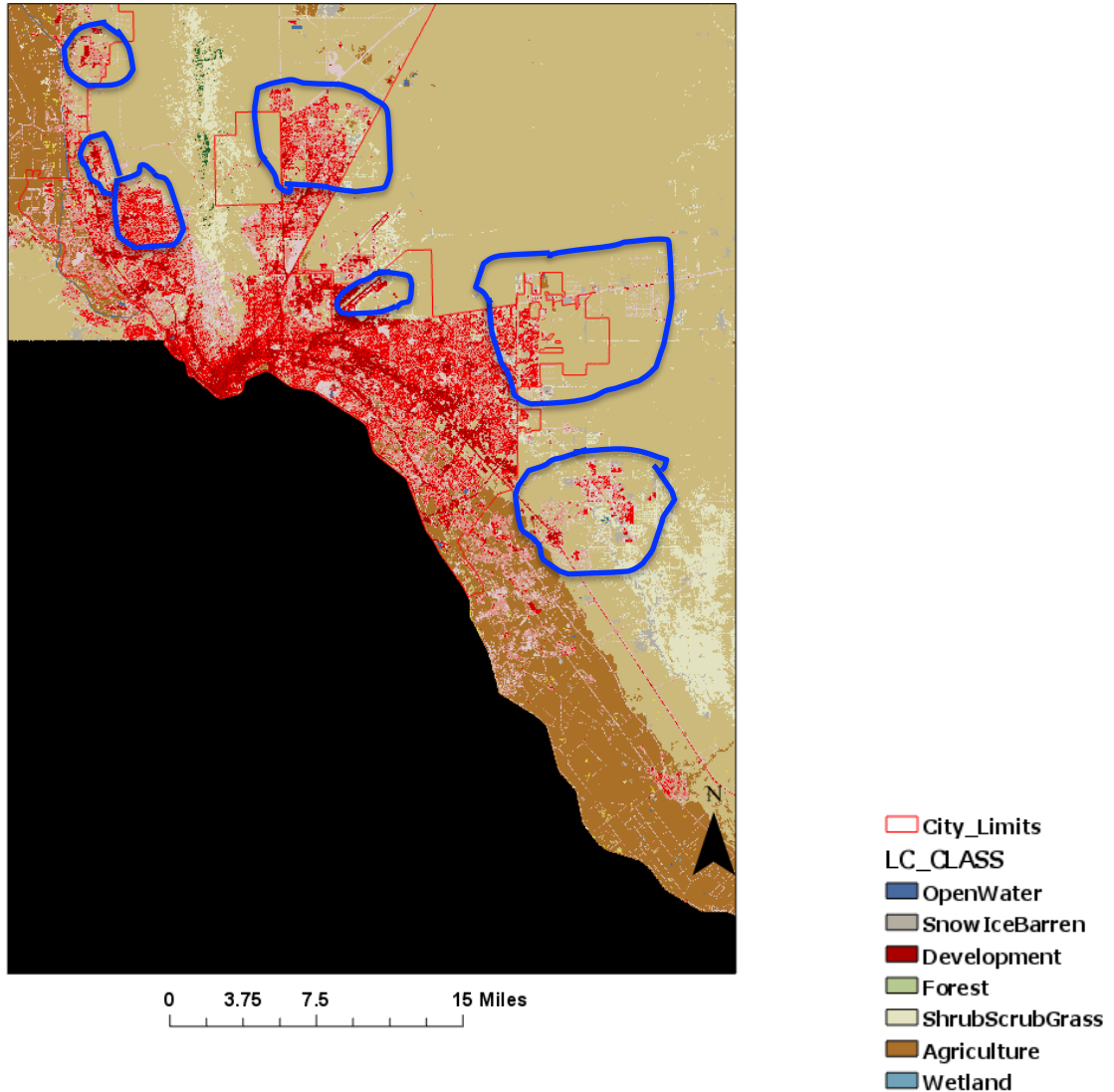Wetland

0   3.75   7.5   15 Miles

Figure 3b (MRLC, n.d.)

The most apparent land cover changes between 2001 and 2006 appear on the outskirts of El Paso City limits. They are illustrated in Figure 3b in blue shapes. The land cover change from scrubland to developed areas in the northeast and northwest parts of El Paso City are the most concerning as they overlap with large A SFHA zones. Without

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appropriate flood control regulations, these growing areas will have greater problems with
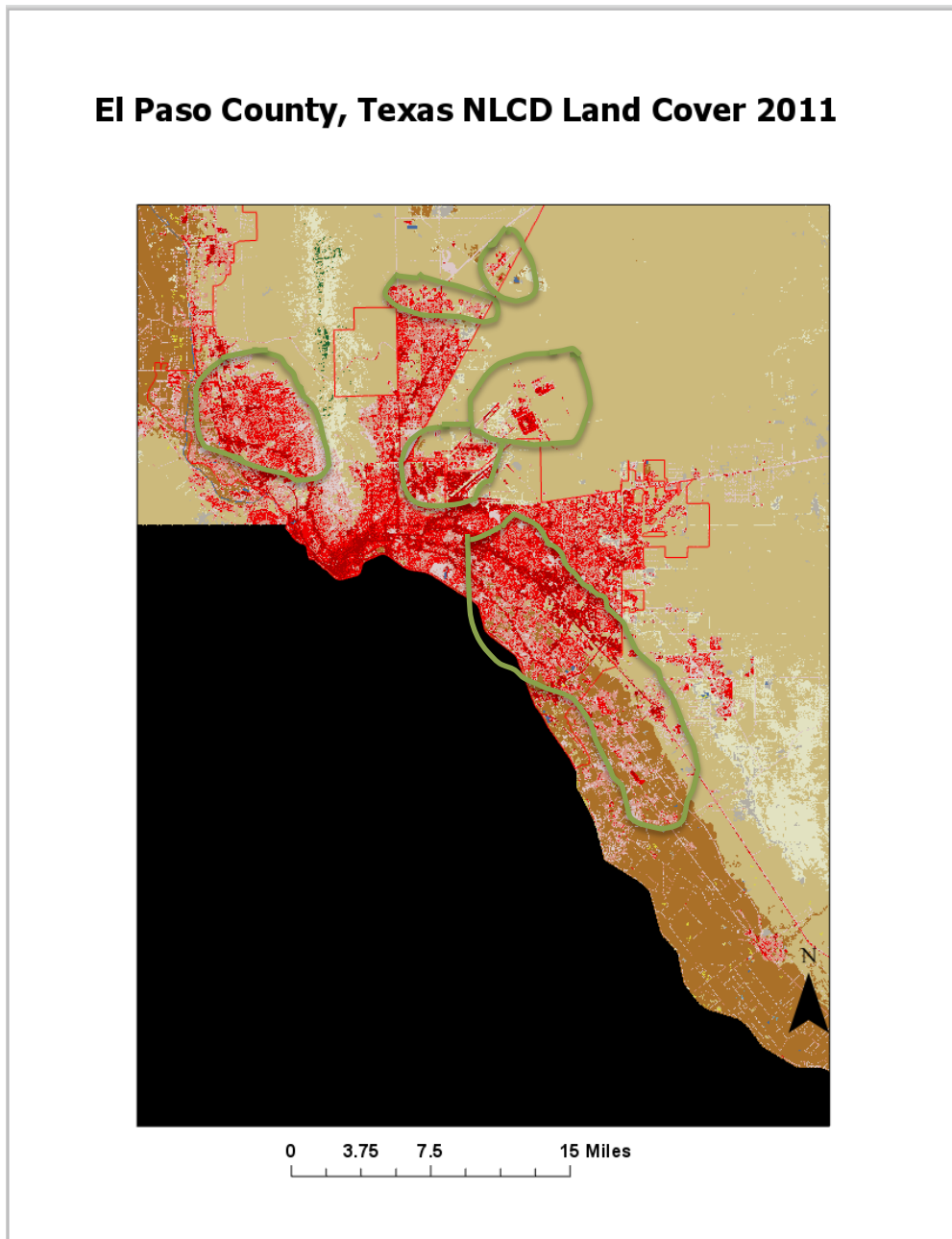
flooding in the future.

Figure 3c (MRLC, n.d.)

The most apparent land cover changes between 2001 and 2011 are in El Paso City's

inner northwest corner and the far southeast corner that extends beyond the city limits to

the adjacent towns along the Rio Grande.   There are also signs of further development

around Fort Bliss in the northeast corner of El Paso City. These developments are illustrated in Figure 3c in forest green shapes.

The development in El Paso City's northwest corner lies at the base of the Franklin Mountains, which is a cause for flooding concerns. As figure 2b confirms, that area is home to a large A SFHA zone. The increase in concrete surface for streets and home foundations will exacerbate the waterfall effect of the Franklin Mountains during rainfall events. This occurs as impenetrable land cover not only fails to absorb fast flowing water but also fails to obstruct its flow in the way scrubland would. This allows water to flow more quickly, which in turn overwhelms drainage infrastructure at the bottom of the mountain. Consequently, flash flooding occurs in lower areas adjacent to the mountain.

This effect also harms residents in the southeast corner of El Paso City and surrounding communities as the large volume of water heads downstream and potentially overflows the banks of the Rio Grande. More impermeable land cover in this area only intensifies flooding. The El Paso County government must work in conjunction with El Paso City government to develop urban planning solutions that maximize scrubland cover across the city, but especially in the foothills of the Franklin Mountains.

Flood control measures could range from ordinances requiring property owners to have a minimum amount of permeable land cover to overhauls in the storm system that involve investments in pervious concrete. Pervious concrete could channel storm water away from the Rio Grande and toward artificial holding ponds away from El Paso City that could store extra drinking water supplies for the county or channel the water into the river at a much slower and steadier pace. Unfortunately, pervious concrete and artificial holding

ponds are ambitious and expensive investments that would likely require funding from the

state and federal governments and thorough surveys to asses efficacy.

Flood Risk Areas & Census Block Group Median Income

Image 3: Sparks Arroyo Colonia southeast of El Paso near the Rio Grande (Flores, 2016).

Colonias, very low-income communities in El Paso County, have the most difficult

time recovering from flooding events due to extreme poverty and the lack of local

government resources because many are unincorporated (Collins, 2010; Collins, Grineski,

& de Lourdes Romo Aguilar, 2009). Figure 1 in Collins (2010) indicates that the *colonias* of

El Paso County are home to about 70,000 people as of 2000. Figure 1 (Collins, 2010) also

shows that annual per capita income in the *colonias* is only $17,444, government revenue

per capita is lowest at only $317, and only 20% of damaged homes in the 2006 flood had

flood insurance as compared to 94% of damaged homes on El Paso City's wealthier west

side. Figure 2 in Collins (2010) classifies census block groups in El Paso County on a social

vulnerability scale from low to moderate to high. Variables to determine categories were

poverty status, educational level, US Citizenship status, and per capita revenue from local

government (see note 4 in Collins, 2010). Unsurprisingly, Figure 2 (Collins, 2010) placed

colonia communities in El Paso County in the highest social vulnerability category.

El Paso County, Texas Block Group Median Income 2010

Legend:
- City_Limits
- El_Paso_Block_Group_Income
- JOIM001
  - ≤9443
  - ≤17982
  - ≤31701
  - ≤55331
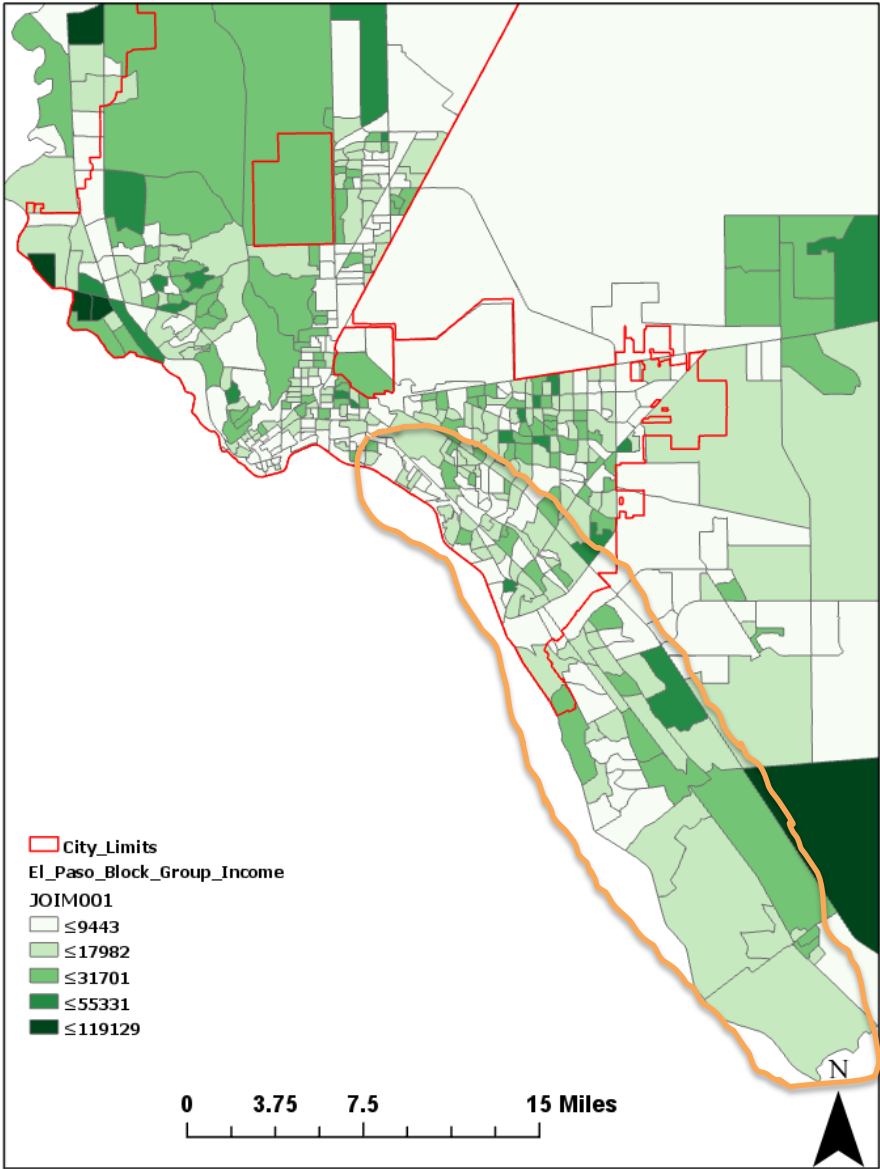 - ≤119129

0   3.75   7.5   15 Miles

N

Figure 4a (US Census Bureau, 2010)

The orange polygon in Figure 4a encircles the *colonia* communities to which Collins'

(2010) Figure 2 was referring. As the map shows, a sizable portion of these subdivisions

has been incorporated into El Paso City limits. This fact could improve prospects for

improved infrastructure in these neighborhoods by making them eligible for City of El Paso

aid (Collins, 2010). The encircled census block groups in Figure 4a correlate well with

Figure 2's (Collins, 2010) mostly high social vulnerability designation. Most of these block

groups have a median annual income as of 2010 of less than $18,000; many have a median
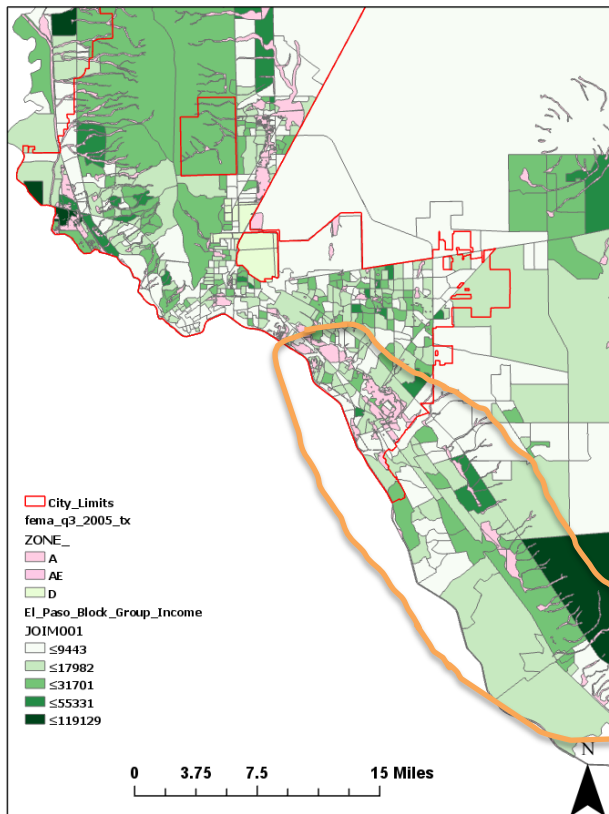
annual income of less than $9,500.

Figure 4b (US Census Bureau, 2010)

Figure 4b highlights the fact that the encircled block groups in Figure 4a also primarily lie in A SFHA zones. The overlap of low-income census block groups with large A SFHA zones provides pivotal evidence to Collins' (2010) assertion that *colonia* communities close to the Rio Grande in southeast El Paso City and as well as those adjacent to the southeast El Paso City limits have some of the highest flood risks in El Paso County. The picture of Sparks Arroyo *Colonia* (Image 3) conveys further validity to this claim by showing houses that are very close to a wide dry river bed that can produce devastating floods during a rain event.

Given El Paso County's past negligence of these communities, their flood risk is likely higher than figures indicate due to a probable lack of guidance from local government on housing placement, materials, and foundations that can withstand floods (Collins, 2010; Hill, 2003). Additionally, *colonias* were mainly ineligible for FEMA assistance grants after the 2006 flood incident because most homes are built without a permit and therefore outside the jurisdiction of government oversight (Collins, 2010). Hence, El Paso County and City governments as well as FEMA must provide more flood control resources to these underserved communities in order to improve their ability to withstand floods.

Current Flood Control Infrastructure

After the 2006 flood events, El Paso City Council issued bonds for increased storm water infrastructure, bought out some high flood risk properties, and created a special "Stormwater Utility" run by El Paso Water Utilities (EPWU) dedicated to handle flood dangers (Crowder, 2006; Collins, 2010). Because EPWU provides 90% of municipal water supplies in El Paso County, the stormwater utility covers the vast majority of incorporated

El Paso County communities (EPWU, 2015).   The stormwater utility has spent nearly $650 million on 100 different flood infrastructure improvement projects since its inception (EPWU, 2009). These include improvements to pump stations, retention ponds, and storm drain conduits (ibid). Stormwater utility crews also remove vegetation, debris, silt, and other obstructive objects from stormwater conveyance channels to facilitate water flow (EPWU, 2009). 10% of the fees EPWU customers pay to the stormwater utility finances projects that control water flow naturally such as parks and other green spaces (ibid). Although these projects are a step in the right direction, not enough time or research has occurred to accurately determine if these projects significantly offset flood impacts from land cover changes (see Figures 3a, 3b, 3c).

In a report published after the 2006 floods, the International Boundary and Water Commission called for improvements to the dam and levee system on the Rio Grande in El Paso County and other surrounding counties to contain a 100-year flood event (IBWC, 2007). The call for these improvements came after FEMA studies could not certify that the infrastructure in question could adequately control water volumes from 100-year flood events (ibid).   Upgrades included raising levees by three feet at the Chamizal National Monument, installing flood gages at two major international bridges between the US and Mexico, and constructing a floodwall and raising levees in Canutillo in northwest El Paso County (IBWC, 2007). The IBWC also called for sediment dredging at Chamizal and Canutillo (ibid). All projects started in the year 2007 and were mostly scheduled to be completed by the end of that year.

Conclusions & Further Research

El Paso County's topography and land cover trends are pivotal factors in determining the county's vulnerability to future floods. The fact that about 10% of the county's population consists of very low-income residents living in *colonias* located in a dangerous flood plain (see Figure 4b) attests to the importance of addressing flooding issues in El Paso County (Collins, 2010; City of El Paso, 2016). The classification of many El Paso County census block groups as 'highly socially vulnerable' (see Figure 2 in Collins, 2010) further emphasizes the need to address flood hazards in El Paso County.

More research is required to determine current population figures in census block groups and on the correlation between the location of A SFHA zones and that of low-income populations. Updated FEMA Q3 data could also provide insight into how population growth and associated land cover change has altered A SFHA zones. Studies into the different soil types and their ability to absorb water on the east and west sides of El Paso City could provide urban planners a clearer idea into how much homeowners and businesses can count on the soil to mitigate floods. Lastly, more studies are necessary to ascertain if El Paso County, El Paso City, and IBWC flood infrastructure improvements will make a substantial difference in the next major flood event in light of population growth and land cover changes across El Paso County.

References

Collins, T. W. (2010). Marginalization, facilitation, and the production of unequal risk: The 2006 Paso del Norte floods. *Antipode*, *42*(2), 258–288. http://doi.org/10.1111/j.1467-8330.2009.00755.x

Collins, T. W., Grineski, S. E., & de Lourdes Romo Aguilar, M. (2009). Vulnerability to environmental hazards in the Ciudad Juárez (Mexico)–El Paso (USA) metropolis: A model for spatial risk assessment in transnational context. *Applied Geography*, *29*(3), 448–461. http://doi.org/10.1016/j.apgeog.2008.10.005

EPWU. (2009). El Paso Water - Stormwater Master Plan. Retrieved December 2, 2016, from
http://www.epwu.org/stormwater/stormwater_master_plan.html

EPWU. (2014). *El Paso Water Utilities 2014 Water Conservation Plan As per Rule 363 . 15
Required Water Conservation Plan Texas Water Development Board*.

EPWU. (2015). El Paso Water Utilities - Public Service Board | El Paso's Water Resources.
Retrieved November 22, 2015, from
http://www.epwu.org/water/water_resources.html

Flores, A. B. (2016, September 12). County to explore possibility of stormwater fee. *The El
Paso Times*, p. 1. El Paso. Retrieved from
http://www.elpasotimes.com/story/news/local/community/2016/09/12/county-
explore-possibility-stormwater-fee/90285012/

Hill, S. (2003). Metaphoric Enrichment and Material Poverty: The Making of
"Colonias" In Pablo Vila (Ed.), *Ethnography at the Border* (1st ed., pp. 141–
166). Minneapolis: University of Minnesota Press. Retrieved from
https://books.google.com/books?hl=en&lr=&id=vKAPW7ikaREC&oi=fnd&pg=PA141
&dq=population+colonias+el+paso+county+texas&ots=qI1D-tc8OH&sig=d-
Piizksfsb6Uj1ovwCefN9jDaA#v=onepage&q=population colonias el paso county
texas&f=false

IBWC. (2007). Rio Grande Flood Control Levees El Paso County , Texas. In *Rio Grande Flood
Control Levees El Paso County, Texas Fact Sheet* (p. 6). El Paso: International Boundary
and Water Commission. Retrieved from
http://www.ibwc.state.gov/Files/ElPasoLeveeFactSheet_060407.pdf

Michelsen, A. (2006). Federal Flood Assessment Conference Recommendations and
Proceedings (pp. 1–50). Retrieved from
http://agrilifecdn.tamu.edu/elpaso/files/2011/10/Federal-Flood-Assessment-
Conference-Proceedings-Report-Final-wo-Appendix.pdf

MRLC. (n.d.). Multi-Resolution Land Characteristics Consortium (MRLC). Retrieved
December 2, 2016, from http://www.mrlc.gov/nlcd01_data.php

NFIP. (n.d.). UNIT 3: NFIP FLOOD STUDIES AND MAPS.

Paso, C. of El. (2016). *The Parks and Recreation Master Plan*. El Paso. Retrieved from
https://www.elpasotexas.gov/~/media/files/coep/parks and recreation/0-
masterplan-0/14-ch4.ashx?la=en

Schoenemann, C. (2016). El Paso County looks to find over $70,000 to cleanup illegal
dumping | KFOX. KFOX - El Paso/Las Cruces. Retrieved from
http://kfoxtv.com/news/local/el-paso-county-looks-to-find-over-70000-to-cleanup-
illegal-dumping

US Census Bureau. (2010). TIGER/Line® with Data. Retrieved December 2, 2016, from
https://www.census.gov/geo/maps-data/data/tiger-data.html

US Census Bureau. (2014). El Paso County, Texas. Retrieved November 28, 2016, from
http://www.census.gov/quickfacts/table/RHI605210/48141

USGS. (n.d.). EarthExplorer. Retrieved December 2, 2016, from
http://earthexplorer.usgs.gov/

Viesca-Santos, C. Owner Of Trucking Company Sentenced For Dumping Demolition Waste
Illegally - County Attorney Press Releases (2007). Retrieved from
http://www.epcounty.com/CS/blogs/ca_press/archive/2010/05/18/owner-of-
trucking-company-sentenced-for-dumping-demolition-waste-illegally.aspx