Chapter 3: Mobile Homes and Climate Risks in Florida

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Abstract

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1 Introduction

Mobile homes make up an important and often overlooked source of affordable housing in the United States. Florida, a state highly exposed to climate stressors such as flooding, sea level rise, and hurricanes, is one of the top states for total mobile home units (US Census, 2023). Recognizing that for low-income renters, mobile homes may act as a better alternative to similarly priced site-built rental units (Boehm and Schlottmann, 2008), there is a need to further develop the nascent literature analyzing the relationship between mobile homes and climate risks.

In this paper I analyze the level of exposed risks for mobile homes, both private and land leased, throughout Florida by quantifying the number of mobile home units located in flood and hurricane storm surge zones. I integrate spatial data on mobile home parks and private mobile home parcels with climate risk data defining flood and hurricane storm surge zones for the entirety of Florida. I then use a spatial join to identify parcel locations in or out of a given climate risk zone. Following a similar study by Baker et al. (2014) looking at mobile home exposure to climate risks in Vermont, this analysis provides important information for local governments and emergency workers tasked with managing climate risk for mobile homes.

In the first step of my analysis I investigate the extent to which many mobile home parks and private mobile home parcels are exposed to different flood hazards throughout Florida. This analysis distinguishes between lots in mobile home parks and private mobile home parcels to account for the differences in the type of tenure status (Durst and Sullivan, 2019; Sullivan, 2022). Lots in mobile home parks involve a unique tenure arrangement called a

land lease, where households own the mobile home but rent the land it sits on. On the other hand, private mobile home parcels occupy land that is owned by the mobile home household. The difference in tenure status presents unique challenges in dealing with climate risk (Lamb et al., 2022).

In the next step of my analysis I ask how climate exposure aligns with the different mobile home production eras. Originally, mobile homes were introduced to circumvent building codes placed on site-built housing. Yet, the response by local governments resulted in new restrictions on mobile home placement in residential areas (Sullivan et al., 2022). Starting in 1976 the US Department of Housing and Urban Development (HUD) established a uniform federal building code titled, the Federal Manufactured Housing Construction and Safety Standards Act, outlining requirements for the construction of all mobile homes (Manufactured Home Construction and Safety Standards, 24 CFR 3280). These codes were then updated with stricter wind load requirements in 1994 following Hurricane Andrew's near total destruction of mobile homes in Southeast Florida. This sequential increase in building codes describes the different levels of structural vulnerability important to risk accounting (Simmons and Sutter, 2008). Throughout this study, I split these production eras between Pre-1976, $1976 - 1994$, and Post-1994 production.

Finally, I ask how socio-demographic vulnerability correlates with high levels of climate exposure. I do this by first identifying the top 5 risk exposed counties to Category 5 storm surge throughout Florida. Then I characterize socio-demographic variables that can compound climate vulnerability throughout the mobile home neighborhoods using median income, minority concentration, and age profiles (Cutter et al., 2003; Sullivan, 2022). The prevalence of these social vulnerabilities vary between mobile home locations and can affect

preparation and response to climate risk in different ways. I then use the results of this analysis to provide policy recommendations.

There is an important methodological challenge in this analysis dealing with the available data on mobile home park locations. The mobile home park data provided by Florida's Department of Health locates mobile home parks based on address point locations. The use of points to identify locations within climate hazard zones restricts the analysis of risk since the full extent of a mobile home park is much larger than a single point. I address this challenge by using a spatial join to link mobile home parks with their associated land-use parcels. The creation of this data set provides the opportunity to better summarize risk levels for mobile home parks throughout Florida.

Throughout this study, I combine a number of different data sets including data on mobile home parks, parcel data from the Florida Department of Revenue (DOR), and physical data related to climate hazards. The mobile home park data includes point locations, park names, and ownership information for all registered mobile home parks throughout the state of Florida. Parcel information includes the land use code, building construction year, and the appraised value (referred to as just value). Additionally, the spatial extent for each parcel is provided through a polygon shapefile. The land use codes allow me to filter through the parcel data set, isolating mobile homes and mobile home parks. The last set of data includes storm surge zones provided by the National Hurricane Center (NHC) and digital flood insurance rate maps (DFIRMS) which delineate the flood zones used in this analysis.

Results from this study suggest that risk levels between mobile home parks and private mobile home parcels are consistent throughout different hazard types. The percentage of at risk mobile home parks is slightly larger than for mobile home parcels. Aside from the

most intense hurricanes (Category 4 or 5), flood risk defined by the DFRIMs represents the highest level of exposure to mobile homes throughout Florida. Additionally, the majority of climate exposed mobile home parks are older developments (pre−1976), while the majority of exposed private mobile homes were built between 1976 and 1994.

Overall, Lee and Pinellas County stand out as having the most climate exposed mobile homes for both parks and parcels. These adjacent counties along the west coast of Florida share similar exposure levels but different experiences with recent disasters. In 2021, Lee County mobile homes suffered significant damages from Hurricane Ian while mobile homes in Pinellas County were fortunate to avoid hurricane impacts (Olivo and Craig, 2022). However, the destruction throughout Lee County serves as a cautionary tale for other counties with high levels of climate exposed mobile homes. Lessons from Hurricane Ian suggest that local governments of coastal communities should focus attention on mobile home resilience to maintain these lower-cost, affordable housing options.

In the following section I provide background on mobile home climate vulnerability while describing the role mobile homes can play in providing an alternative option for low-income housing. The rest of the paper is laid out as follows; Section 3 describes the data and methods used for analysis. Section 4 presents the results. Section 5 concludes with a discussion on policy recommendations and study limitations.

2 Mobile Home Vulnerability and Disasters

The field of mobile home research is slowly developing, with its initial roots in sociology and spatial analysis. French and Hadden (1965) provide one of the first peer-reviewed articles

investigating the location and sociodemographic characteristics associated with mobile home communities. Following World War II, the authors identify increasing concentrations of mobile home communities in rural, unincorporated locations along the outskirts of urban centers. Due in part to local zoning and land use codes, mobile home community development remains on the peripheries of urban cores (Dawkins and Koebel, 2010; Mandelker, 2016; Pierce et al., 2018; Sullivan et al., 2022; Rumbach et al., 2022). The separation of mobile homes from traditional housing communities leads to a higher incidence of locations within environmentally risky zones and reduced access to community resources (Shen, 2005; Pierce et al., 2018; Cutter et al., 2003; Prasad and Stoler, 2016; Pierce and Jimenez, 2015; Sullivan et al., 2022). Tate et al. (2021) identify hot spot concentrations of mobile homes in flood zones throughout the US. While Pierce and Jimenez (2015) find that mobile homes have less reliable water service than other housing types, leading to exacerbated vulnerabilities after disaster events. As Lamb et al. (2022) suggests, reduced water reliability is endemic of the old infrastructure systems used in mobile home communities. My work builds on this growing field of research by providing a descriptive analysis that quantifies the level of climate risk faced by mobile homes throughout Florida.

The general ostracization of mobile homes by local government leads to a higher incidence of climate exposure for these communities (Dawkins and Koebel, 2010; Tate et al., 2021; Sullivan, 2022). Both Chaney and Weaver (2010) and Kusenbach et al. (2010) find that mobile home households are less prepared in their disaster evacuation plans than other housing types. These authors find a consistent lack of knowledge related to a household's individual risk and a low level of participation in evacuation prep for hurricane and tornado hazards. For many older mobile homes, risk acknowledgement and evacuation plans will

greatly impact the safety of these households during a disaster. An important contribution of this paper aims to better inform policy makers, and in turn individual households, about the risks mobile homes face.

After Hurricane Andrew destroyed 94% of the mobile homes along its path (compared to 11% of site built homes), stricter building codes were implemented by HUD. Simmons and Sutter (2008) go on to show the efficacy of strengthened building codes finding that mobile homes built after 1994 were 79% more likely to survive storms during the 2004 and 2005 hurricane season than those built before 1976. The implementation of stricter building codes for mobile homes has played an important role in enhancing the climate resilience of these structures. In this study, I integrate previous work on the structural vulnerability of mobile homes by analyzing age related climate risk throughout the mobile home stock in Florida. While exposure is one important determinant of risk, the structural integrity of exposed units contributes important information to our understanding of mobile home risk.

Overall, mobile homes play an important role in providing needed affordable housing (Boehm and Schlottmann, 2008); yet, the discrepancies in tenure status for mobile home households present challenges preparing for and recovering from disaster events (Sullivan, 2022). Rumbach and Makarewicz (2016) explain how mobile home residents were uniquely affected by the 2013 Colorado floods due to a lack of legal protections and the prohibitively high costs of relocating trailers. Further, Lamb et al. (2023) explains how instability in housing tenure reduces the ability of households to incorporate protections against varying climate stressors. Mobile homes located within mobile home parks own the home, but rent the lots they occupy. Whereas, mobile home households on private land own both the house and the property in a more traditional site-built set up (Durst and Sullivan, 2019).

This distinction of land ownership has important implications for the type of insurance and disaster aid available to these households (Rumbach et al., 2022). In this study, I contribute to the discourse on climate adaptation challenges for mobile home households by comparing levels of climate risk for the different tenure types. The policy recommendations I put forth, focus particularly on mobile home parks, due the important vulnerability challenges brought on by semi-ownership.

3 Data and Methods

This section describes the data and methods used; including mobile home parcels, registered mobile home parks, and the climate risk variables describing flood and storm surge zones.

3.1 Private Mobile Homes

Florida's Department of Revenue collects property tax data and GIS shapefile parcels from the property appraisal office in each county[1]. I obtain a data set of property tax information linked with GIS parcel boundaries for all parcels throughout the state of Florida (FGDL, 2023). This data set includes information on the land use designation for each of the parcels. I subset the parcels using land use code (002) to identify the private mobile home units throughout the state.

The data set includes the variables just value, defined as the property's market value, the physical address, and the year built. I assign an elevation and distance to the nearest

[1] A description of the available data and process for downloading the data is provided at Florida's Department of Revenue website https://floridarevenue.com/property/Pages/DataPortal_RequestAssessmentRollGISData.aspx

shoreline for each parcel using the centroid of the mobile home parcels. Table 1 provides a summary of the descriptive statistics for these variables.

Table 1: Mobile Home Descriptive Statistics

	Just Value ($)		Elevation (m)		To Coast (km)	
Type of Hazard	Out	In	Out	In	Out	In
Flood Zones						
100 Year	89,724	121,336	21.58	9.47	19.13	10.96
500 Year	88,801	116,112	22.94	8.32	20.31	9.37
Storm Surge						
Category 1	90,663	151,132	20.91	1.75	19.11	0.68
Category 2	89,857	132,904	21.95	2.31	20.13	1.02
Category 3	89,499	123,414	22.92	2.80	21.11	1.36
Category 4	89,091	116,098	24.28	3.51	22.44	2.03
Category 5	89,197	112,650	25.01	3.91	23.17	2.41

Note: This table provides summary statistics for private mobile home parcels on the average appraised value of a mobile home property ($), the average elevation (meters), and the average distance to the coast (kilometers). The groups of mobile homes are split based on a mobile home parcels exposure designation.

Table 1 shows that on average mobile homes located within hazard zones are valued higher than mobile homes located outside of these zones. The higher average value of homes in hazard zones is likely due to their coastal proximity, a positive amenity for many homeowners as well as higher land costs in these locations (Rouwendal et al., 2017). As demonstrated in Table 1, mobile homes in flood zones are on average two times closer to the coast than mobile homes outside of these flood zones. The difference in average just value is larger when comparing mobile homes exposed and not exposed to the different storm surge categories. Similar to mobile homes in flood zones, mobile homes exposed to storm surge hazards are nearly twenty times closer to the coast than non exposed units.

3.2 Florida Mobile Home Parks

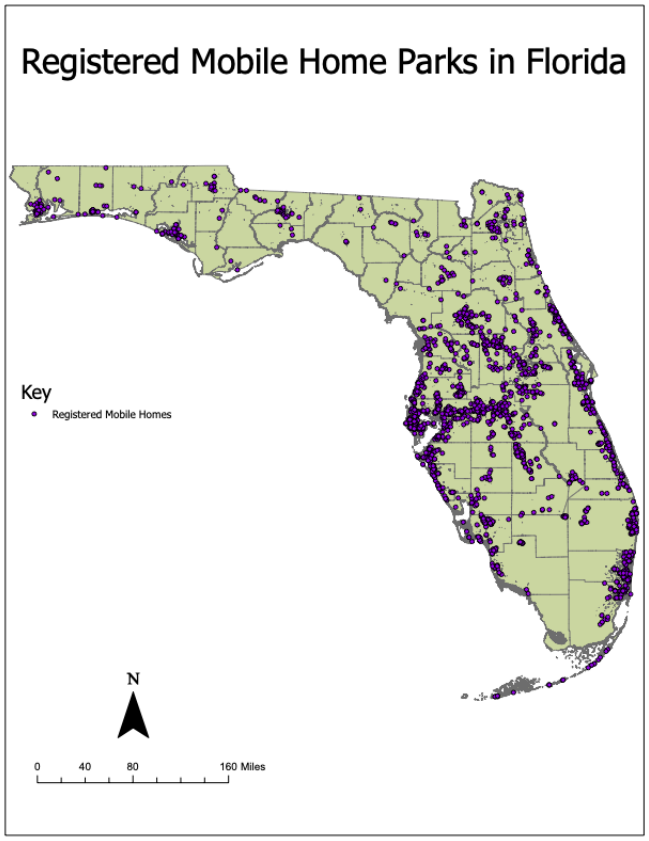
Mobile homes within mobile home parks present a unique tenure situation where households own their mobile homes but rent the land they occupy. These properties represent different land use codes (028) in the parcel data set than single unit mobile homes. The Florida Department of Health is responsible for the approval and record keeping of mobile home parks throughout the state. I obtain data for mobile homes parks from The Shimberg Center for Housing Studies at the University of Florida, which provides spatially located data of all of registered mobile home parks in Florida's Department of Health database[2](Shimberg, 2023).

The data set of registered mobile homes includes variables on the parks project number, the park name, a single-point location for the park, and the number of lots in the park. Due to the large size of mobile home parks a single point cannot adequately represent the entirety of climate risk for mobile home units within the park. To overcome this challenge, I take the point location for each mobile home park and match them with parcels identified as mobile home parks in the DOR database. I use a spatial join to calculate the shortest distance from a given mobile home park to the accompanying polygon in the DOR database. This allows me to assign the spatial extent of a mobile home park in the DOR database with validated mobile home park information from the Department of Health.

However, inconsistencies in data management from property appraisal offices led to an incomplete joining process. Mismatches between mobile home park points and mobile home park parcels can result in biases due to incorrect parcel matching. Therefore, to minimize

[2]Florida's Department of Health provides licenses for mobile home parks throughout Florida and facilitates a uniform program each county health department must follow when inspecting, reviewing, and enforcing actions for mobile home parks within their respective counties.

Figure 1: Mobile Home Parks in Florida



Notes: This map provides the point location for all mobile home parks used in this analysis.

potential issues I focus on park parcels within 100 meters of the Department of Health's mobile home park point. This process results in the analysis of 1,692 registered parks (instead of the full 2,1971).

Figure 1 provides a map of the mobile home parks used in this analysis. Many of these mobile home parks are located along the coast of Florida, with particularly high concentrations in the mid-western part of the state. As I discuss in Section 4.2, counties with the highest count of climate exposed units, Lee and Pinellas County, are located along the mid-western coast of Florida.

3.3 Climate Layers

There are two sources of climate risk data used for this analysis. The first set identifies flood zones throughout the state of Florida (FEMA, 2022). These flood zones are delineated into two levels of risk, the 100-year flood zone and the 500-year flood zone. These layers are created by the Federal Emergency Management Agency (FEMA) and are known as Digital Flood Insurance Rate Maps (DFIRMS). The 100-year flood zone represents flooding events with a return period of 100 years. Parcels located within these zones have an annual 1% likelihood of being flooded. The 500-year flood zone represents flooding events with a 500 year return period and show that households located in these zones have an annual 0.2% likelihood of being flooded.

The second set of climate risk data provides information on household locations in or out of a hurricane storm surge zone. Storm surge is defined as the increase in water level over the astronomical tides from a hurricane (Zachry et al., 2015). The storm surge data set is created and maintained by the National Hurricane Center (NHC). Each data layer for the five different categories of hurricane intensity (on the Saffir-Simpsion scale) is represented with a raster layer. The raster layers depict the maximum level of high tide storm surge estimated from hundreds of thousands of hurricane simulations (Zachry et al., 2015). I delineate storm surge impacts using a dichotomous approach. I assume all parcels within the surge boundaries are at risk while those outside the surge zone are not[3].

[3] This assumption ignores the intensity of flooding (broken down by depth of flooding) that is provided from the probabilistic hurricane models

3.4 Risk Identification

I use two different approaches to characterize mobile home risk throughout Florida based on the classification of land tenure. First, I identify private mobile home parcels within risk zones based on the location of their parcel centroids. Mobile home parcels are much smaller than mobile home parks and only contain individual mobile home units. This fact enables the simplifying assumption of using point geometries for my private mobile homes risk assessment. I assign each of the $437,943$ mobile home parcels into their respective flood and storm surge zones.

For mobile home parks I incorporate the full polygon geometry into risk identification. I use polygons due to the size of mobile home parks and my inability to delineate individual mobile homes throughout these parks. The key assumption I make in quantifying mobile home park risk assumes that individual mobile homes are uniformly distributed throughout the mobile home park. Therefore, parks with $X\%$ of their property within a climate risk zone implies that $X\%$ of the mobile homes within the park are exposed to that given risk. This process of calculating the percent of each mobile home park located within a climate risk zone is used for both the flood and storm surge hazards. This presents a lower bound of risk within mobile home parks, since mobile homes within these parks are likely clustered together.

4 Results

The first part of the results section describes the levels of climate risk for private mobile homes versus mobile home parks. The second part presents the relationship between the

development era and climate risk. The third section identifies counties with the greatest levels of climate exposed mobile homes and reports important socio-demographic characteristics.

4.1 Mobile Home Risk

Table 2 provides a comparison of climate risk levels for mobile home parks, rented mobile home lots, and mobile home parcels on owned land. The climate risks are split into different groups based on the type of hazard. The first two columns $MHPs$ and $MHP(\%)$ provide the count and percent of mobile home parks with any fraction of property located in a risk zone. The next two columns display the count and percent of rented mobile home lots (from the mobile home parks) located within a given risk zone. Finally, the last two columns describe the count and percent of mobile home parcels located in a given risk zone.

For all three of the mobile home types, there is approximately a 5% increase for the count of properties located within the 500 year flood zone relative to the 100 year flood zone. Overall, private mobile homes have the highest representation of units in both the 100 year and 500 year flood zones; however, mobile home parks and their associated mobile home units have a higher percentage of units in these flood zones. Mobile homes located in mobile home parks are consistently cheaper than their privately owned counterparts, due their lower costs of occupation (land ownership versus land rents) (Durst and Sullivan, 2019). Therefore the households that live in climate exposed mobile home parks are likely more vulnerable than the climate exposed households living in private mobile homes.

Results in Table 2 further suggest that storm surge from hurricanes is the greatest hazard threat to mobile homes in Florida. While hurricane return periods differ based on intensity

Table 2: Mobile Home Exposure in Florida

	Rented				Owned	
Type of Hazard	MHPs	MHP (%)	MHP Lots	MHP Lots (%)	MH Parcels	MH (%)
Flood Zones						
100 Year	937	55.38	54,893	23.75	78,943	18.03
500 Year	1030	60.87	70,039	30.30	106,159	24.24
Storm Surge						
Category 1	267	15.78	19,408	8.40	34,458	7.87
Category 2	355	20.98	32,725	14.16	56,664	12.94
Category 3	439	25.95	47,113	20.38	76,520	17.47
Category 4	538	31.80	62,502	27.04	102,707	23.45
Category 5	608	35.93	71,498	30.93	116,282	26.55

Note: This table presents three different summaries of mobile home climate exposure in Florida. The first two columns present the count and percent of mobile home parks with any property intersecting with the given climate hazard. The next two columns present the count and percentage of mobile home lots within a mobile home park that are located in the given climate hazard. These counts are obtained by multiplying the percent of a mobile home park located in a hazard zone with the total number of lots in the park. Finally, the last two columns represent the count and percentage of private mobile home parcels with a centroid point located in the given climate hazard.

and location all of the different return period combinations occur more frequently than a 1 in 100 year storm (Keim et al., 2007). Therefore, the higher counts of mobile home parks and private mobile home parcels exposed to high intensity hurricane events imply that hurricane hazards are the greatest threat to mobile homes throughout Florida.

4.1.1 Development Eras

Table 3 provides the counts of mobile home parks in different climate hazard zones based on the time of their development. However, the available data on mobile home parks cannot capture the age profile for each unit within a park. Mobile homes are built ready to live in and are transported directly to the land they will occupy. Very few mobile homes are relocated after the initial transport due to an increased probability of damages and high costs of transportation (Sullivan, 2018). Therefore, it is assumed that each mobile home unit within the park is at least as old as the construction of the park. For every level of climate

risk, parks built prior to 1976 make up the largest share of exposed parks. Assuming that parks developed prior to 1976 are populated by mobile home units built during a similar era, the majority of climate exposed mobile home parks throughout Florida contain structural vulnerabilities.

Table 3: Mobile Home Park Development Eras

	Flood Zones		Hurricanes				
Development Era	100 Year	500 Year	Category 1	Category 2	Category 3	Category 4	Category 5
Pre 1976	526	585	169	222	272	330	371
1976-1994	230	242	45	65	83	105	119
Post 1994	77	88	21	28	38	43	49

Note: This table provides an age breakdown for the development year of mobile home parks located within each of the provided climate risk zones. The period of development for each mobile home park does not necessarily represent the age profile for each unit within the mobile home park. Parks are identified as being in a climate risk zone if any part of their property intersects with the given hazard.

Table 4 provides the year of build breakdown for private mobile home parcels located within each of the given climate risk zones. Table 4 results demonstrate that mobile homes built between 1976 and 1994 constitute the largest share of climate exposed private mobile homes. Mobile homes constructed during this time period have stronger and more uniform building codes than units built prior to 1976. However, Table 4 shows that mobile homes constructed after 1994, when the strictest building codes were enacted, make up the smallest percentage of at risk units for each different hazard type.

Table 4: Mobile Home Development Eras

	Flood Zones		Hurricanes				
Development Era	100 Year	500 Year	Category 1	Category 2	Category 3	Category 4	Category 5
Pre 1976	22,806	30,820	11,561	19,578	26,959	34,978	37,970
1976-1994	33,791	45,731	15,606	25,238	33,021	42,840	48,303
Post 1994	21,543	28,532	7,115	11,499	16,030	24,236	29,215

Note: This table provides age breakdown of the construction year for each mobile home parcel located within the provided climate risk zone. The year built statistics represent when each mobile home parcel was constructed and thus which building code guidelines the homes were built under.

4.2 High Risk Counties

Table 5 presents the top 5 counties for mobile home park exposure to the Category 5 storm surge hazard. Pinellas County has the highest count of exposed mobile home lots with 62% of their lots exposed. Lee County has the second highest count, with approximately 3,000 less exposed units than Pinellas but 3,000 more exposed units than Hillsborough. Both Hillsborough and Volusia County have less than 50% of their lots exposed to storm surge from Category 5 hurricanes. Miami-Dade County has the fifth highest count of lots in mobile home parks exposed to Category 5 storm surge with 5,720. The top 3 most exposed counties are all located along the west coast of Florida.

Table 5: Top 5 Counties of Mobile Home Lot Exposure to Category 5 Storm Surge

	Mobile Home Parks		2020 Census			
County	Lot Count	Lot (%)	Median Income ($)	% Hispanic	% Black	% Elderly
Pinellas	12442	61.86	47,055	10.57	6.29	31.77
Lee	9970	92.04	51,080	14.94	3.32	44.22
Hillsborough	6762	45.61	53,838	31.60	11.77	16.27
Volusia	6085	41.35	44,398	9.67	7.70	29.79
Miami-Dade	5720	64.86	45,510	74.65	16.93	15.23

Note: This table presents the top 5 counties with the highest count of lots in mobile home parks exposed to storm surge from a Category 5 hurricane. The socio-demographic variables are averages of census-blocks containing the mobile home parks. The elderly percentage of the population is defined by individuals over the age of 65.

Table 5 also includes information on the average socio-demographics of census block groups containing exposed mobile home parks throughout these top 5 counties. Overall, Florida's median income is $57,703 which is higher than the average census block's median income for each of the top 5 counties. The average census block's median income is lowest for Volusia and Miami-Dade County. The low median income for census blocks with highly exposed mobile home parks suggests that households in these neighborhoods have

compounding vulnerabilities that could exacerbate hurricane hazards (Cutter et al., 2003).

Additionally, census blocks containing hurricane exposed mobile home parks in Miami Dade County have a hispanic concentration that is triple the percentage of hispanics living in Florida (25.8%). While census blocks with hurricane exposed mobile home parks in Miami Dade County have a lower concentration of elderly households than the state representation (20.5%), Lee County has more than double the state concentration of elderly households. Overall for these highly exposed counties, a high concentration of elderly households represents the greatest social vulnerability which adds to their climate risk.

In Table 6 I display the top 5 counties for private mobile home exposure to Category 5 hurricane storm surge. Similar to the two counties with the most exposed mobile home parks, Lee and Pinellas County also have the highest count of exposed private mobile homes. Lee County has nearly all of its private mobile home units exposed to high intensity hurricane hazards. While Pinellas County has the second highest count of exposed private mobile home units to Category 5 storm surge, the percent of the total exposed stock is greater for private mobile homes than lots in mobile home parks. Nearly all of the private mobile home parcels in Sarasota County are exposed to Category 5 storm surge, while the percent of the private mobile home stock exposed to this hazard is less than half for Pasco and Citrus County.

Table 6 also shows that the average median income is greater for census blocks of the highly exposed private mobile homes than for census blocks with highly exposed parks. This supports the fact that private mobile homes are less vulnerable to the impact of climate extremes than mobile homes within mobile home parks. Private mobile homes are afforded greater protections against climate hazard impacts than are lots in mobile home parks, in part due to their status as residential property versus personal property (Durst and Sullivan,

Table 6: Top 5 Counties of Mobile Home Parcel Exposure to Category 5 Storm Surge

	Mobile Homes		2020 Census			
County	Units	Unit (%)	Median Income ($)	% Hispanic	% Black	% Elderly
Lee	16,535	98.89	59,540	19.57	7.14	34.44
Pinellas	12,476	71.00	48,386	9.97	6.27	29.88
Sarasota	11,656	97.46	55,019	7.96	4.56	48.03
Pasco	8,267	28.03	54,102	14.29	5.07	27.64
Citrus	6,106	39.17	45,758	4.12	2.72	37.81

Note: This table presents the top 5 counties with the highest count of mobile home parcels exposed to storm surge from category 5 hurricanes. The socio-demographic variables are averages of census-blocks contraining mobile home parks. The elderly percentage of the population is defined by individuals over the age of 65.

2019; Lamb et al., 2023; Sullivan, 2022). For the particular cases of Pinellas and Lee County, the average median income of exposed census blocks is greater for private mobile home parcels.

Finally, Table 6 suggests that the average census block for exposed private mobile homes are less diverse, but older than the average census block with storm surge exposed mobile home parks. These results support findings by Prasad and Stoler (2016) who find disproportionate levels of lower income and elderly households in their Southeast Florida mobile home sample. Table 6 also shows that private mobile homes have a lower concentration of minority households than is representative throughout Florida. Citrus County has further compounding social vulnerabilities with the second highest concentration of elderly mobile home households and the lowest median income of the top 5 exposed counties. This implies that storm exposed private mobile home neighborhoods within Citrus County are particularly vulnerable to the negative consequences of hurricane exposure.

When comparing statistics between Tables 5 and 6, there is evidence that private mobile homes are less vulnerable, from a socioeconomic perspective, than households in mobile home

parks. Additionally, evidence from Tables 3 and 4 supports the conclusion that mobile home units in mobile home parks appear to be older on average than private mobile homes, making them more structurally vulnerable. Combining these higher vulnerabilities of mobile home parks with results from Table 2 leads to the conclusion that mobile home park residents are the most at risk mobile home type to climate hazards. The high exposure and greater vulnerabilities of mobile homes in mobile home parks suggests that these households have the greatest need for assistance in preparing for and responding to climate hazard events.

5 Discussion and Policy Reccomendations

Throughout this descriptive analysis I describe risk levels for different types of mobile homes, those that lease the land they occupy and those that own the land their home resides on. This dichotomy is used to investigate the structural vulnerability of mobile homes by characterizing the building code eras they were produced in. Additionally, I analyze the relationship between hazard risk and socio-demographic vulnerability of the most hazard exposed counties throughout Florida. In general, mobile home park residents face a higher level of climate risk due to higher exposure of mobile home parks and an elevated level of social vulnerability relative to their privately owned mobile home counterparts.

In the following set of recommendations I focus predominately on mobile home parks. Due to differences in land ownership, private mobile home parcels are treated differently by lending institutions and disaster recovery organizations which contributes to an enhanced ability for these mobile home types to bounce back after a disaster event (Sullivan, 2022; Lamb et al., 2023). This descriptive analysis leads to a number of recommendations for

mobile home park residents, emergency managers, and land use planners that can help increase climate resilience within mobile home communities. In these recommendations I discuss cooperative insurance opportunities, targeted information campaigns, as well as development opportunities that can mitigate challenges related to climate preparation and recovery.

First, incentivizing individual climate adaptation is an effective approach to help mobile home communities reduce their climate vulnerabilities while insulating residents from the politics of government funding. In a survey of South Florida mobile home communities, Prasad and Stoler (2016) identify social organization as an important obstacle to hurricane preparation and mitigation. These findings align with a general consensus in the disaster literature that tighter social cohesion is an important variable in disaster recovery (Cutter et al., 2003). Implementing this theory of social cohesion towards disaster preparation lends to a recommendation of increasing the proliferation of resident owned communities (ROCs) (Lamb et al., 2022). With the help of other nonprofits, ROCs create a cooperative where each mobile home resident becomes a shared land owner of the mobile home park in similar fashion to a land trust. The shared land ownership provides greater stability against rising land rents and incentivizes residents to implement climate adaptation measures within their communities (Lamb et al., 2023).

Additionally, the community structure of these ROCs can lend way to what Carolyn Kousky terms "meso-level insurance". In her book, "Understanding Disaster Insurance" Kousky (2022) describes meso-level insurance (or aggregator insurance) as an insurance tool that a non-profit purchases, "and then uses the funds to make needed payouts to others," (148). This approach to community level insurance spreads risk throughout the mobile home

community. However, potential pitfalls of this approach are recognized in the case of extreme disaster events were all community members would be impacted.

Second, my analysis suggests a high proportion of elderly households (residents over 65 years old) in both private mobile homes as well as mobile home parks. My results align with a survey analysis of mobile home residents conducted by **?** in the hurricane prone location of Ruskin, Florida. These authors acknowledge an increased vulnerability of elderly households to hurricane impacts due to reduced mobility and a lack of awareness regarding safety options in the event of a hurricane. Therefore an information campaign by local emergency managers towards elderly households can target specific barriers recognized by these households in their preparation and response to disaster events.

Finally, the strategic location of mobile home development, particularly for mobile home parks, can play an important role in reducing hazard exposure for these vulnerable households. Despite their recognized ability to aid in the supply of affordable housing, Dawkins and Koebel (2010) note many urban areas are devoid of mobile home communities due to restrictive or exclusionary zoning laws. The results I provide in this analysis align with other studies showing that mobile home park development often occurs high risk locations (Sullivan et al., 2022). Adjusting zoning codes that are more inclusive of mobile home parks can contribute to increased development of mobile home communities in less climate exposed areas (Sullivan, 2022). Local governments can prioritize the development of mobile home communities in low risk locations through and understanding of climate risks and the use of spatial analysis software.

These recommendation acknowledges the importance of mobile homes as an important contribution to the supply of affordable housing (Boehm and Schlottmann, 2008; Herbert

et al., 2023). For residents of mobile home parks in Florida, land rents range between $400 to $800 per month and factory production of mobile homes is on average half of the cost of a site built home (Reed, 2023; Burton, 2023). Promoting the quality and safety of these communities presents an important step in addressing climate vulnerability while addressing the pressing challenges of housing affordability.

The results presented in this study provide a baseline level of risk exposure for mobile home parks and parcels throughout Florida. However, further analysis is needed to better understand the nuances of risk that these households face. First, the dichotomous distinction for hazard exposure does not capture the extent of damages that can result for different hazard intensities. Future studies should incorporate higher resolution hazard information with unit specific elevation data to better characterize risk for these homes. Second, further analysis comparing the path to disaster recovery for owner versus leased mobile home tenure is needed. Mobile home households on leased land typically have lower incomes and higher rates of compounding vulnerabilities. Thus, understanding how these different tenured households recover from disaster is important in achieving more optimal post-disaster outcomes.

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