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Relocation, Retreat, and the Rising Sea Level: A Simulation of Aggregate Outcomes in Escambia County, Florida

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Abstract - Using data for a flood-prone county in Florida, this paper analyzes the effects of sea-level rise on migration decisions and destination choices. The data are retrieved from parcel-level tax records, utilizing a name-matching procedure, enriched with synthetic population techniques to generate salient socio-economic attributes of movers and stayers. We find that in the years following a major flood event, households with high perceived risks have elevated migration propensities. We also find that households making ad hoc decisions on retreating from rising waters will in fact stay close to the hazard prone areas. This may eventually necessitate a further retreat, including a costly move.

JEL Classification
Q54, R11, R23

Key-words
Sea-level rise
Retreat
Migration propensities

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INTRODUCTION

Historically, many coastal areas have offered locational advantages, foremost in the form of access to ports and trade routes. Not surprisingly then, a substantial portion of the world population has settled along the coasts, often clustered in large metropolitan areas. The World Ocean Review of 2017 reports that "[a]ccording to estimates by the United Nations, around 2.8 billion people presently live within 100 kilometres of a coast. Of the 20 megacities in the world with populations of more than ten million, 13 are situated near a coast. These cities or areas of high population density include Mumbai (18.2 million), Dhaka (14.4 million), Istanbul (14.4 million), Calcutta (14.3 million) and Beijing (14.3 million). Many experts believe that the urbanization of coastal regions will continue to increase in the coming years." (World Ocean Review 2017, p. 12).

However, proximity to the ocean also bears risks, primarily in the form of flooding. These risks become higher as increasing global temperatures cause global see-levels to rise and severe storms to occur more often. At the same time, population growth and the development of vulnerable coastal land imply ever greater losses when extreme weather events cause flooding and the sea water encroaches further inland. Taken together, the effects of flooding in coastal areas have taken on new proportions, most noticeable in the increasing number of people losing their homes. The large number of flood-induced displacements suggest that mass displacement by extreme weather events may become the norm. A well-known example of such displacements in the U.S. occurred when hurricanes Katrina and Rita hit the golf coast in 2005 (Yun and Waldorf 2016).

Although there is growing support for the claim that the rise of sea levels induces migration (Perch-Nielsen et al. 2008, Hugo 2010, Hauer 2017) there has been relatively little research on the timing and patterns of such sea-level rise induced migration (SLRIM). Most importantly, as of now, the literature has not adequately addressed the small-scale issue of the link between migration and sea-level rise. The problem is that sea level rise does not affect county residents uniformly but only affects residents in comparatively small areas along the coast and along rivers. We fill this gap by investigating migration induced by sea-level rise at a parcel level. Specifically, we focus on the migration decisions of households in flood-prone areas and the associated potential to trigger neighborhood changes. The objective is to get a better understanding of the variations in migration propensities when faced with imminent flooding risks and of the aggregate outcomes of the population redistributions. Two hypotheses are at the center. First, we hypothesize that out-migration rates in sea-level rise affected areas exceed those in areas not affected by sea-level rise. Second, the sea level rise related population redistribution leads to increased poverty rates in high poverty neighborhoods.

We use well-known models for limited dependent variables, namely a logit model to estimate the probability of moving and a multinomial logit model to estimate the destination choice. The estimation results are subsequently used to simulate the population redistribution given specified inundation scenarios. The main methodological challenge is not the model itself, but there are two elements that make the method innovative. First, the predictors explicitly include variables measuring time-varying risk perception. Second, we derive parcel-level migration data that more adequately responds to the small-scale variation of flood risks than the typically large-scale migration data. The empirical case study uses data for Escambia County, Florida, 2010 to 2016.

The remainder of the study is organized as follows. Following this introduction, the first section provides a brief overview of the growing significance of the issue and its treatment in the literature so far. The second section presents the empirical case study, including subsections on the study area, data and data preparation, model specifications, and results. Finally, the paper ends with a summary and concluding discussion.

1. BACKGROUND

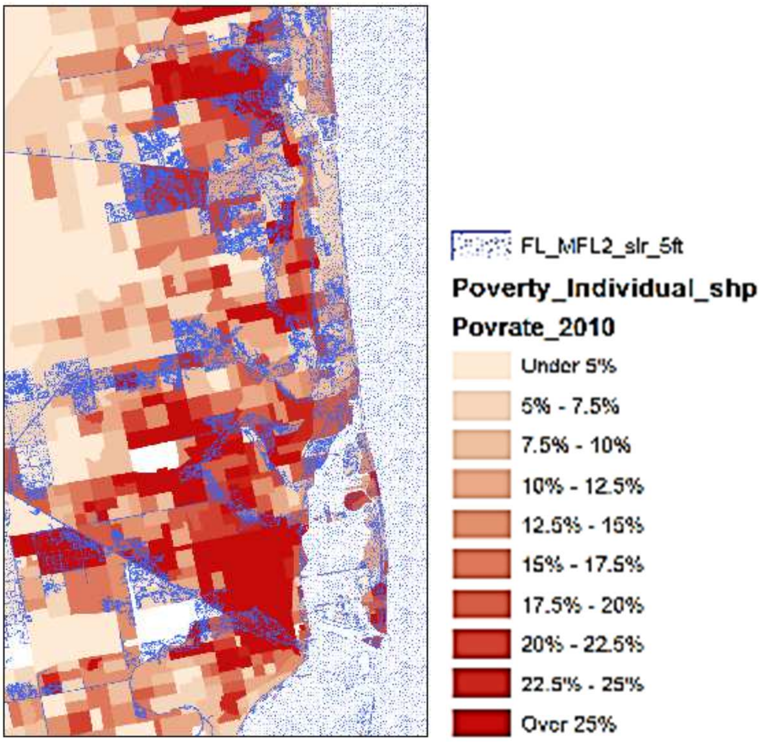
People having to leave their homes due to natural diasters or worsening environmental conditions is an ubiquitous phenomenon, happening and having happened throughout the world at all times. The confluence of enormous population growth – expected are an additional two billion people in just thirty years (Waldorf 2018) – and rapid environmental change, has contributed to the displacement of large numbers of people in recent years. At the global level, the Internal Displacement Monitoring Centre (IDMC) in Geneva reports that, during the first half of 2019, disasters were responsible for about seven million internally displaced persons (*IDMC 2019).* The vast majority of these displacements were associated with storms and floods. Cyclone Fani in May of 2019 had the worst impact, displacing almost 3.5 million people in India and Bangladesh. Kulp and Strauss (2019) emphasize that – while the climate change driven global mean sea level rise was modest during the last century – the sea level is expected to rise more substantially in the years ahead, even when carbon emissions are cut sharply. They juxtapose the state-of-the-art sea-level projections with population size and distribution and conclude that, by 2050, up to 340 million people will live on land below the flood level. By the end of the century, the flood threatened population will have increased to up to 630 million.

The urgency to address these issues is growing. Indicative is the emergency statement, signed by thousands of scientists from across the world and published just days before the 2019 Climate Summit in Madrid. The scientists declare, "[…] clearly and unequivocally that planet Earth is facing a climate emergency. Exactly 40 years ago, scientists from 50 nations met at the First World Climate Conference (in Geneva 1979) and agreed that alarming trends for climate change made it urgently necessary to act. Since then, similar alarms have been made through the 1992 Rio Summit, the 1997 Kyoto Protocol, and the 2015 Paris Agreement, as well as scores of other global assemblies and scientists' explicit warnings of insufficient progress (Ripple et al. 2020). Yet greenhouse gas (GHG) emissions are still rapidly rising, with increasingly damaging effects on the Earth's climate. An immense increase of scale in endeavors to conserve our biosphere is needed to avoid untold suffering due to the climate crisis (IPCC 2018)." (Ripple et al. 2020).

With sea level rise being one of climate change's most visible, long-lasting adverse outcomes threatening the livelihood of millions of people, the focus needs to shift towards how to respond to the inevitable consequences. Given the large number of people living in the flood-prone areas threatened by an eventual complete inundation, the costs are expected to be very high. For the United States, for example, studies suggest that – although uncertainty exists regarding the exact magnitude – the sea level rise is expected to adversely affect almost one million people. Moreover, flood costs in the United States are expected to exceed 2,000 billion dollars per year by the end of the century (Hinkel et al. 2014; Strauss et al. 2012).

In the past, the population often returned to flooded areas once the water receded and adapted by, for example, strengthening levies. Such a strategy will eventually no longer be feasible as adaptation strategies become too costly or even become unavailable given the ever rising waters. Therefore, Hino et al. (2017) and Mach et al. (2019) argue that policy makers and planners need to strategically integrate retreat into their set of tools tackling sea level rise. They refer to it as strategic and managed climate retreat. Already, we witness relocation and migration in reaction to a rising sea level. For instance, Kivalina village in Alaska requested funds from the federal government for relocation because of rising sea levels. In most cases, however, people move away from flood-prone areas in a more ad hoc fashion, independent of any larger strategic plan. Such ad hoc relocation decisions by individual households may, however, be inherently inequitable as low-income households will have comparatively fewer resources to tackle the risks (Mach et al. 2019). Such inequities may include that displaced low-income households are spatially constrained in their destination choices and disproportionately relocate to poor neighborhoods. Ultimately, such spatially constrained moving behavior fosters a further concentration of poverty.

Figure 1. Inundation area of Miami, FL given a 5ft SLR (blue), overlayed with 2010 poverty rates

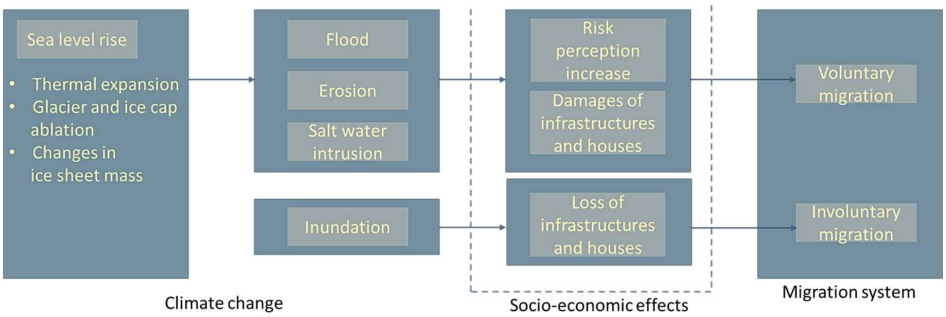


Migration as a mechanism leading to poverty concentration has received increased attention over the past decades, but has not yet been addressed in the context of SLRIM. One of the more persistent characteristics of migration patterns in the U.S. is that poor migrants tend to move toward poorer areas (Foulkes & Schafft, 2010; Jivraj, 2011). This pattern will increase poverty rates in high poverty areas, while it will decrease poverty in other areas. In the case of minor sea-level rise, only the immediate coastal areas will be affected. Typically, the residents of the immediate coastal areas are higher-income households. However, when the sea level rises more than 2 to 5 feet, lower-income neighborhoods further away from the coast and along the river beds will be affected as well and it is therefore reasonable to expect sea-level rise induced migration to change the geography of poverty. As an example for the co-location of sea-level rise high poverty, Figure 1 shows the spatial co-location of 5-ft inundation areas and areas of high poverty in Miami, FL.

We argue that poverty's spatial redistribution is likely to happen along well-known trajectories of short distance relocation for three reasons. First, SLRIM is predominantly voluntary migration rather than forced migration (Gold & Nawyn, 2013) because sea-level rise is a slow and gradual process. Increased flood frequency alerts residents to the risk of sea level rise, and consequently induces households to move away before complete inundation by the sea. Second, the literature suggests that SLRIM follows established migration networks (Curtis & Schneider, 2011; Gold & Nawyn, 2013; Hugo, 2010). That is, while sea level rise induces migration, sea level rise does not change housing preferences. Third, the effects of sea level rise are primarily local. Therefore, current small-area migration patterns can be used to examine patterns of sea level rise-induced migration.

However, in the absence of detailed and systematice data collection efforts that connect flooding/inundation events and relocations, many of the relevant studies concentrate on conceptual ideas about sea-level rise induced migration. Perch-Nielsen (2004), for example, conceptually differentiates sea-level rise induced migration as consisting of two components: a voluntary migration process and involuntary migration processes (see Figure 2). Involuntary migration will happen through governmental actions or when the area becomes completely inundated. Prior to inundation, however, flooding frequency increases, neighboring areas become inundated, and people begin to perceive the flooding risk as imminent, eventually resulting in voluntary migration.

Figure 2. Link between Sea-Level Rise and Migration (modified from Perch-Nielsen, 2004)



Gold and Nawyn (2013) expanded the conceptual framework suggested by Perch-Nielsen (2004) by adding that migration patterns will be similar to those during the pre-flooding era. Their argument is that inundation will only affect the push and pull factors of a limited portion of coastal areas. As a result, most population migration patterns will remain the same as those currently observed.

The historic example of retreat from Holland Island, MD, confirms these conceptual ideas. Gibbons and Nicholls (2006) investigated the abandonment of the island after the sea-level rose in the late 19th Century. From 1850 to 1900, the population of Holland Island had increased from 37 to 253. But when coastal erosion started, around 20 percent of the population left because of the loss of land. As the community continued to lose population, it was no longer able to sustain itself. As a result, the island was completely abandoned in 1920 although most residents were not directly affected by the sea-level rise. This example shows that SLRIM can trigger and thus be similar to economically motivated voluntary migration.

There are only few studies going beyond conceptual and descriptive accounts of sea-level rise induced migration. Curtis and Schneider (2011) used spatial and temporal sea level rise data and linked it to migration. Identifting time and location of inundation and assuming that migration flow patterns are time-invariant, they estimate flooding-induced relocations. Most notable, they find that more than half of Florida's population would migrate to other states. Similarly, Hauer (2017) used US county-level migration data to estimate demographic changes by SLRM and specifically focused on destinations of SLRM. He similarly assumed that SLRM will follow past migration patterns and uses 1990 – 2013 inter-county migration data from the Internal Revenue Service. The result showed that most of the migration would happen in Florida, and almost half of sea level induced migrants in Florida will migrate to other destinations within Florida. In addition, he showed that the Austin-Round Rock, TX, metro area will have the most significant population gain due to SLRIM.

2. EMPIRICAL CASE STUDY

2.1. Study Area

Our study focuses on Escambia County in Florida, 2010 to 2016. The county borders Alabama to the West and the Gulf of Mexico to the South. It includes the low-lying Island of Santa Rosa which stretches form East to West parallel to the coast line.

The US Census[1] reports that Escambia County has about 315,000 inhabitants. Its major city and county seat, Pensacola, has about 52,000 residents. Among the county population, the non-Hispanic white population accounts for about two-third. The black population is the largest minority group and makes up almost a quarter of the population. Escambia County is not a very wealthy county when compared to the national averages. The median household income is only $47,000, the poverty rate amounts to 16.4 percent, and only 26 percent of the adult population has at least a bachelor's degree. Escambia County's housing stock is comprised of 142,000 housing units, 61 percent of them are owner-occupied. The median value of the owner-ocupied units is $126,000. In the rental housing sector, the median gross rent is $928.

Importantly, Escambia County experienced several major flooding events in recent years.[2] In 2012, Escambia County was severely affected by the June 8–11, 2012 Gulf Coast Flood Event. A slow moving system stalled tropical airmasses over Alabama and western Florida, producing widespread and long lasting showers and storms across the coastal areas. One weather station in Pensacola recorded more than 300 mm of rain in just 9 hours. Flooded roads, businesses and residences were widespread. In fact, according to the emergency services, most of western Pensacola was flooded.

Even more devastating was the flooding that occurred on April 29–30, 2014 in connection with two storms passing over the Alabama and Florida area. Escambia County received record breaking precipitation amounts, with a 2-day total of 520mm. In the worst hour of the storms, 144mm precipitation in just one were recorded. Not surprisingly, the damages were severe, including life-threatenning flash floods. Low-lying areas were submerged and the infrastructure failed. The

[1] Unless otherwise noted, the data in this section have been taken from the U.S. Census https://www.census.gov/quickfacts/fact/table/escambiacountyflorida.

[2] The details were extracted from NOAA's National Weather Service information at https://www.weather.gov/mob/2012_JuneFlood and https://www.weather.gov/mob/2014_April29_FlashFlood

Governor of Florida declared a state of emergency for the county and President Obama declared it a federal disaster, providing funds for the recovery during the subsequent years.

2.2. Data

2.2.1. Migration data

The U.S. Census Bureau collects data on individual's and household's moving behavior, for example in the annual American Community Surveys (ACS) and the Current Population Surveys (CPS). However, the publicly accessible geographic identifiers for movers' origins and destinations in these surveys refer to relatively large geographic areas of at least 100,000 residents. Given the large spatial scale, they are not suitable for this study.

Instead, we generate a sample of movers and stayers from Escambia County's property tax records which refer to a small spatial scale, namely individual parcels. The sample is confined to single family owner-occupied housing, and we further select only those properties that can be associated with a name that only shows up once in the records, i.e., a "unique" name (see Figure 3). Parcels owned by persons who own more than one property in Escambia County are thus eliminated. Omitted are also parcels owned by persons who happen to have the exact same name as another parcel owner.

To identify movers and stayers among the parcel owners, we use a parcel-level name matching process suggested by Sun and Manson (2015). Persons are defined as "stayers if they are attached to the same parcel in two consecutive years. Persons are defined as movers if they are attached to different parcels in consecutive years. Note that this procedure does not identify persons who are moving out of Escambia County, or who are moving from a single family house into rental housing. To reduce the possibility of false mover/stayer identifications, we separate co-owners as two persons. Moreover, we removed suffix/inheritor and middle names because of inconsistencies regarding their inclusion in the official records.

2.2.2. Socio-economic data

The property tax records do not include socio-economic attributes of property owners. We use a synthetic population to assign socio-economic proxies. The construction of the synthetic population proceeds in two steps: first, we use the micro-level ACS data to create a synthetic population for each census tract; second, we employ an iterative proportional updating as proposed by Ye et al. (2009) to derive parcel-level proxies of the key socio-economic attributes from the synthetic census-tract population.

Table 1. Sample Characteristics

Year	*n*	Movers	% Black	%Hispanic	Mean HH Income	Mean Perceived Risk
2012	13,23	566	17%	1.7%	$67,268	0.02
2013	13,429	400	17%	3.0%	$69,170	0.04
2014	12,973	518	15%	3.3%	$71,346	0.04
2015	14,097	677	17%	2.9%	$70,739	0.01
2016	14,083	708	15%	3.5%	$72,868	0.01

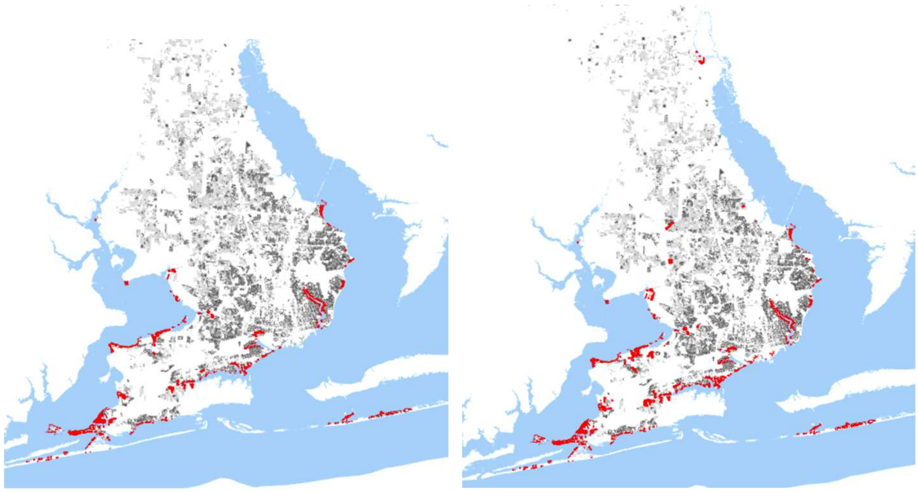
Table 1 summarizes averages of the generated data. It reveals that the share of black households is substantially smaller in the sample than in Escambia County as a whole, whereas the average household incomes is much higher. These gaps are not surprising given that the sample concentrates on owner-occupied single-family homes where blacks and low-income households are traditionally underrepresented. The sample propensity to move varies between 3 percent in 2013 and 5 percent in 2016. These figures are compatible with observed intra-county relocation rates for home-owners.

The last column of Table 1 shows the mean perceived risk for a given year. Perceived risk is operationalized as home insurance relative to the home value. The means vary between 0.01 in 2016 to 0.04 following the June 2012 flood and during the year of the April 2014 flood.

2.2.3. Sea-level rise data

Sea-level rise data are obtained from NOAA's Office for Coastal Management. We identified sea-level rise induced inundation areas and subsequently matched it with parcel-level data. Figure 3 shows the inundated areas in Escambia County when the sea-level rises by 5 ft and 10 ft, respectively. Interesting to note is that the 10ft rise includes a good deal of areas that are not in immediate proximity to the coast line.

Figure 3. Inundated areas for sea levels rise of 5ft (top) and 10ft (bottom)



2.3. Model

Adopting the standard random utility framework, we specify the probability that household i will choose to move as a function of the household's utility of moving, U_{im}, exceeding the utility of staying, U_{is}. Let M_i be the random variable distinguishing household i moving, $M_i = 1$, versus household i staying $M_i = 0$. Then the probability of moving is:

$$P(M_i = 1) = P(U_{im} > U_{is})$$

Assuming that the utility function U can be additively separated into its observable part V and unobservable ε, the probability of moving takes on the form:

$$P(M_i = 1) = P(V_{im} + \varepsilon_{im} > V_{is} + \varepsilon_{is})$$

Finally, assuming that the unobserved parts of the utility are independent and identically Weibull distributed, and that the observable utility function is a linear combination of salient attributes, $X\beta$, then the probability of household i deciding to move can be expressed as the well-known logit expression:

$$P(M_i = 1) = \frac{exp^{V_{im}}}{exp^{V_{im}} + exp^{V_{is}}} = \frac{exp^{X_{im}\beta}}{exp^{X_{im}\beta} + exp^{X_{is}\beta}}$$

The key variable entering the linear predictor $X\beta$ is the perceived risk (*risk*), which we operationalize as home insurance relative to the home value. Moreover, we allow the *risk* parameter to vary over time by including the interaction effects with the year fixed effects. As control variables we include the household income (*hh inc*), the house mortgage (*mortgage*), and we distinguish owners by race and ethnicity, using the dummy variables *black* and *hispanic*, respectively. The model is estimated with $n = 97{,}435$ observations, using maximum likelihood estimators.

Confining the sample to those who moved ($n = 7{,}934$), we designed a multinomial choice model for households' decisions where to move.[3] We distinguish between $K = 3$ possible destinations: moving to another residence in the same census tract, to a neighboring census tract, or to some other location in the ounty . Let $S_i = 1, 2{,}3$ be the random variable indicating household i's location selection, then the probability that household i chooses location k takes on the form:

$$P(S_i = k) = \frac{exp^{W_{ik}}}{\sum_{r=1}^{3} exp^{W_{ir}}} = \frac{exp^{Z_{ik}\beta}}{\sum_{r=1}^{3} exp^{Z_{ir}\beta}}, k = 1{,}2{,}3$$

The linear predictor, $Z\beta$, includes variables identifying the household's race, ethnicity, housing value and household income.

2.4. Results

2.4.1. The decision to move

Table 2 shows the estimation results for the model of households' decisions to move. To begin with, the parameter estimates for the control variables suggest that households' migration propensities increase as budgetary constraints weaken, by lowering the amount of mortgage owed or through income increases. We do not find significant racial or ethnic differences in the overall probability of moving, but the sign of the estimates hint at minorities being less likely to move than the white non-hispanic majority. Moreover, this conclusion is supported by the highly significant negative marginal effect of the variable *hispanic*.

The results for the *risk* variable need to be interpreted jointly with the results for the year fixed effects. We find that the combined parameter $\hat{\beta}_{risk} + \hat{\beta}_{yr}$ is positive for all years (*yr*), except for 2011. This suggests that perceived risk increases a household's probability of moving. With respect to the magnitude of the effect, Table 2 includes the marginal effects evaluated for different high risk levels, including 75%, 90%, and 95%. The results for 2015 and 2016 stand out. These are the two years following the major flood events during which substantiall efforts were dedicated to the recovery from the 2014 flood. For these two years, the estimated marginal effects at the high risk-levels are significantly positive. These estimates are compatible with the notion that flooding, especially in high risk areas, operates like a push factor in the decision to move.

[3] Note that by not linking the destination choice model with the decision to move, we implicitly assume that the moving decision is not relevant to the subsequent locational choice. While this simplifying assumption is debatable, we decided to maintain it so as to make the subsequent simulations manageable.

Table 2. Estimation Results for Model 1: Probability of Moving

	b	SE_b	Marginal Effects at the mean		
black	-0.078	0.091	-0.0027		
mortgage	**-0.269**	0.083	**-0.007**		
hispanic	-0.064	0.188	**-0.006**		
hh inc	0.001	0.001	**0.00005**		
yr 2010	-0.347	0.213	-0.00007		
yr 2011	-0.009	0.243	0.0009		
yr 2012	-0.272	0.228	-0.001		
yr 2013	**-0.551**	0.206	-0.0014		
yr 2014	-0.297	0.195	0.0031		
yr 2015	-0.203	0.245	**0.0061**		
yr 2016	-0.293	0.231	0.002		
risk	**-21586**	11355	165.47		
			risk=75%	risk=90%	risk=95%
risk 2010	21850	19450	0.0005	0.002	0.0029
risk 2011	1678	18724	0.0015	0.0026	0.0032
risk 2012	27015	19556	0.0025	0.0062	0.008
risk 2013	**36714**	18118	0.002	0.0057	0.0075
risk 2014	**22532**	13071	0.0037	0.0054	0.0063
risk 2015	28005	22446	**0.0068**	0.0086	0.0096
risk 2016	36000	22924	0.0059	**0.0094**	**0.0111**

Significant estimates in bold (α<0.05, one-tailed test).

2.4.2. The destination choice

The estimation results for the destination choice model are summarized in Table 3. They suggest that moving very short distances to a new residence in the same census district is the preferred choice of movers in Escambia County. The preference of staying in the same neighborhood when moving to a new residence is particularly strong for those having few financial constraints, that is, households that enjoy a high housing value and high income. Movers with fewer financial means are less likely to stay within their origin neighborhood. The results show that the housing value is the main determinant of migration. When housing price is high, then people will move to the same or adjunct census tracts. In addition, Hispanics are more likely move to other census tracts.

With respect to racial differences, blacks are more likely than whites to choose a new residence that does not require a simultaneous switch of the neighborhood. The remaining racial and ethnic groups are numerically quite small and we cannot find any significant systematic behavioral differences compared to the white majority population.

2.4.3. Simulations

We used the estimations of the destination choice model to simulate what will happen when portions of the county are inundated due to sea level rise. By and large, the results suggest that the households having to retreat due to rising waters will choose to move only short distances, many of them even moving to a new residence in the same census district.

When the sea level rises by 5 feet, a total of 3,395 single-family houses are affected. Among those 3,395 houses, 505 or 14.9 percent were occupied by African

Americans households. Thus, African American households are underrepresented among those having to retreat. Similarly, Hispanic households are underrepresented among those having to retreat. Only 43 houses or 1.3 percent of the affected houses were occupied by Hispanic households. Finally, less than 3 percent of the affected households have incomes below the threshold. Significant increases in poverty concentration in already poor neighborhoods cannot be confirmed.

Table 3. Estimation Results for Model 2: Destination Choice

Variable	$\hat{\beta}$	$SE_{\hat{\beta}}$	t
	relocating to adjacent census tract		
housing value	-0.192***	0.0051	-37.65
hh inc	-0.00003	0.0000259	-1.16
black	-0.77**	0.407	-1.89
asian	-15.5	983.5	-0.02
multi	-0.879*	0.586	-1.50
hispanic	-13.15	1007.434	-0.01
	relocating to a non-adjacent tract		
housing value	-0.738***	0.00366	-201.64
hh inc	-0.000007	-0.0000081	0.86
black	-0.737***	0.266	-2.77
asian	-1.086	0.816	-1.33
multi	-0.098	0.403	-0.24
hispanic	0.742	0.858	0.86

**** α =.01; ** α =.05; * α = .10 ; one-tailed tests.*

When the sea level rises by 10 ft, a total of 6,238 single-family houses will be affected. Among the 6,238 houses, 1,106 or 17.7 percent of the houses were owned by African American families, approximately matching the overall sample share. Hispanic households reside in 78 of the affected houses, again representing only a small share of only 1.3 percent. Compared to the 5 ft rise, the share of poor household among those having to retreat was substantially higher, amounting to 5.7 percent or 356 households. However, compared to the population as a whole, the share is very low. The low share is expected given that the sample had to be confined to owner-occupied single family homes. Moreover, their destination choices of the poor households did not exhibit any significant clustering in already high poverty areas.

3. CONCLUSIONS

This paper analyzes the effects of sea-level rise on migration decisions and destination choices, addressing two research questions: (1) how do flooding/sea level rise affect residents' decision to move, (2) where do households relocate when pushed to retreat from flooded or inundated areas.

Since the Census and other publicly available data only have limited information about migration at a suffiently small spatial scale suitable to analyze SLRIM, we are generating migration data from annual property tax records. This allows us to analyze the migration behavior of homeowners at the parcel-level. From the tax records, we use a name-matching procedure to generate a pool of homeowners who can be identified as movers (relocated to another residence in the county) or stayers (did not relocate). The property tax data provides information on the house, including a time-varying risk variable, and we use synthetic population techniques based on census data to attach socio-economic attributes to the households. The analysis is confined to Escambia County, FL, 2010 to 2016. The county experienced severe flood events in 2012 and 2014.

Estimating a logit model of the probability of relocating, we find that in the years following the 2014 flood event, households with high perceived risks have elevated migration propensities. With respect to the destination choice, we find that relocating households generally tend to move short distances, staying in the same census tract or moving to a neighboring district. This preference rises with households increasing financial security. Ceteris paribus, the preference for short distance moves is also stronger for blacks than for whites. Transplanting these results into sea-level rise scenarios suggests that for Escambia County, the majority of affected households are white and the share of low-income households is underrepresented. The redistribution of the SLRIM is not leading to significant changes in segregation patterns.

This study contributes to our knowledge of inner-county relocations following the flooding and or indundation by sea-level rise. Earlier studies, for example, Hauer (2017) examined inter-county migration following sea level rise. Based on our results, however, studies investigating retreat in response to flooding and sea level rise need to be conducted at a much smaller scale. Our findings suggest that households making ad hoc decisions on retreating from rising waters will in fact stay close to the hazard prone areas. This may eventually necessitate a further retreat, including a costly move. In this sense, our study supports the case for strategic and managed retreats from rising waters, as Hino et al. (2019) recently expressed in general for adverse climate change outcomes.

The study's limitations are rooted in the lack of appropriate data at a small spatial scale. Flooding and inundation do not, as of now, threaten entire counties, but much smaller units like parcels, blocks, or block groups. Future research is needed that is based on surveys of households living in flood prone areas. Those surveys need to include information on the socio-economic and demographic attributes of those who moved and those who stayed put, as well as geographic identifiers of origin and destination at very small-scales.

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Une simulation des comportements de relocalisation résidentielle dans la commune d'Escambia County en Floride face à l'élévation du niveau de la mer

Résumé **–** En s'appuyant sur les microdonnées d'une commune inondable de Floride, cet article propose d'étudier l'effet de la montée du niveau de la mer sur les migrations résidentielles et sur les choix de localisation des ménages. Les données sont issues des statistiques des impôts locaux et enrichies d'informations sur les arrivées et les départs des habitants. Ce travail montre que les migrations sortantes augmentent considérablement dans la commune pendant les années qui suivent un épisode d'innondation majeure. Il montre également que des ménages qui quittent les zones inondables choisissent de se relocaliser dans des lieux relativement proches de leur ancien domicile et restent, à terme, exposés aux risques futurs de nouvelles inondations.

Mots-clés

Elevation du niveau de la mer

Traît de côte

Migration