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Residential buyouts as environmental mobility: examining where homeowners move to illuminate social inequities in climate adaptation

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Abstract

This study examines where residents move after accepting federally funded buyouts of their flood-prone homes. We use the concept of "environmental mobility" — defined as local, voluntary moves undertaken in the face of imminent environmental risk — to distinguish this type of climate adaptation from longer-distance and less-voluntary types of movement. We then use the case of Houston, Texas — the site of more than 3000 such buyouts between 2000 and 2017 — to build a unique dataset that enables, for the first time, address-level analysis of such environmental mobility. Results affirm that most people who move from residences of publicly identified environmental risk relocate to destinations nearby. Results also indicate that this environmental mobility reflects and thus seems to depend on racialization processes of neighborhood attainment, thereby challenging a purely technocratic framing of current buyout policies and illuminating the racialized nature of environmental mobility more generally.

Keywords Urban · Environment · Adaptation · Mitigation · Migration · Mobility

The present study investigates where homeowners move after accepting federally funded buyouts of their residential properties because of repetitive flood risk, which we conceptualize as an important but understudied type of local environmental migration. Broadly and to date, research on environmental migration has established two fundamental points: such investigation is worth pursuing; and, it is difficult to do (see Hino et al. 2017; Hunter et al. 2015). It is worth pursuing because our environment — especially in the form of natural hazards — poses significant and growing challenges to places where people have settled, raising prospects of relocation. Rising seas and significant disaster costs spanning nearly every county in the USA (Elliott and Howell 2017) attest to that fact, as do mounting policy efforts to build more resilient

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neighborhoods, cities, and regions. At the same time, conducting research on related migratory flows is complicated by a number of factors.

One of these factors is the paucity of good data due to what Bilsborrow (2016) calls the "rare element" problem, or the failure to capture in adequate number the relatively infrequent occurrence of residential moves from widely available point-in-time censuses and surveys. This deficit occurs in affluent as well as poor countries and is compounded when attention turns to homeowners, who move less often than renters but own and thus control threatened residential properties, thereby making them central players in local planning and policy efforts. Another challenge to quality research is the fact that in all but the most extreme cases, it is difficult to reliably identify who is moving for environmental reasons. Existing research tells us that this difficulty is here to stay because environmental pushes infrequently operate alone, making them hard to identify (Hunter et al. 2015; McLeman 2018; Piguet et al. 2018). Indeed, recent data from the American Housing Survey indicate that less than 1% of households report moving explicitly because of a natural hazard.[1]

To rise to these challenges, scholars can take several analytic steps. One is to be more innovative with data collection efforts so that relevant subjects are more efficiently targeted for study.[2] In addition, recent reviews of the environmental migration literature (Hunter et al. 2015) also encourage researchers to focus on particular locales where environmental conditions can be more readily identified and held constant alongside other factors that also influence relocation, such as local housing and labor market conditions and policy efforts. In this geographically targeted approach, researchers can more clearly specify the type of environmental migration under investigation while also opening the empirical door to analysis of shorter distance moves, which remain an understudied type of environmental migration despite being the most prevalent form of residential relocation by far (Crowder and South 2008). Indeed, one of Ravenstein's (1885) original "laws of migration" is that shorter moves are more common than longer ones — a point echoed in Lee's (1966) more contemporary "theory of migration."

With these points in mind, we focus the present study on a specific type of environmental migration: local moves voluntarily undertaken by homeowners in response to a publicly identified environmental threat. We refer to this type of residential relocation as "environmental mobility" to distinguish it from more general and typically longer-distance moves signaled by the more encompassing and common term of environmental migration. In documenting the prevalence of this type of mobility and investigating where it leads in terms of relative neighborhood status, we seek to bring environmental concerns into existing urban scholarship on residential mobility. In

[1] This assessment comes from analysis of the 2013 American Housing Survey (AHS), accessed online in June 2019 at https://www.census.gov/ programs-surveys/ahs.html. The survey offers a representative sample of more than 45,000 U.S. households, and mobility is defined as change in housing units during the prior 2 years.

[2] A bit of simple math underscores the importance of targeted data collection. Say one is interested in the "environmental" moves of local homeowners. If, as national surveys indicate, only about 1% of Americans report moving because of a natural hazard in the given year, and if only 65% of Americans are homeowners, then collecting data for a modest sample of, say, 200 cases of interest from a random sample of households would likely require $200 \times 100 \times 1.5 = 30{,}000$ completed surveys. If one factors in non-response rates, the number of households surveyed further increases, driving costs beyond the reach of all but the most well-financed research teams.

addition, we also seek to highlight how such scholarship, with its emphasis on processes of neighborhood attainment and related racial inequalities, can further illuminate processes of climate relocation.

To collect data on environmental mobility, we innovate by using a database of all homeowners in a major U.S. urban area who voluntarily sold their housing to the government because of imminent, publicly acknowledged environmental risk. In all cases, observed moves are assured to be permanent because of subsequent demolition of the departed home and voluntary because of government guidelines. We focus specifically on federally funded buyouts in Harris County, Texas — the central county of the Houston metropolitan area, with boundaries largely coterminous with the City of Houston. Flooding in Houston is manifold, limited not to select waterfront areas but dispersed across the metropolis, affecting every ethnoracial and socioeconomic group. Because Houston is also a major site of environmentally motivated buyouts, with more than 3000 of them already carried out before Hurricane Harvey and many more now planned in the wake of that disaster, the area offers an ideal case in which to examine the local intersection of environmental mobility, federal policy, and neighborhood attainment. Using records from the Harris County Flood Control District — the local entity that manages government buyouts — we construct a unique database that contains address-level information on where buyouts occurred and where participants resettled, thereby answering Hunter et al.'s (2003: 23) call to investigate the dynamics of migration and environmental concerns at "more precise geographies" than the county level.

Overall, our chief interest lies in reliably identifying hard-to-find environmental movers, affirming their propensity to relocate locally, and comparing the social status of their origin and destination neighborhoods to learn more about how Americans voluntarily, if reluctantly, engage in environmental mobility. In the process, we seek to build and strengthen scholarly bridges between the study of environmental migration and urban studies in ways that enrich and expand insights and future research at the crossroads of environmental migration, social inequality, and urban adaptation.

Residential buyouts as environmental mobility

Over the past two decades, tropical cyclones from Katrina to Sandy to Harvey and numerous flood events in between (USGS 2019) have compelled policymakers in urban areas to enact new initiatives designed to help cities better respond to and recover from climate-related threats. New York City, for example, has established an Office of Climate Policy and Programs that recently unveiled an ambitious new plan to tackle climate change through its own local version of the "green new deal" known as OneNYC 2050. Similarly, New Orleans' newly formed Office of Resilience and Sustainability proposes "bold yet pragmatic actions to adapt our city to our changing natural environment, invest in equity, create flexible and reliable systems, and prepare for future shocks." These urban and regional efforts increasingly interlink with new global nonprofit initiatives such as the 100 Resilient Cities (Spaans and Waterhout 2017) and C40 Cities networks to make any claims about "solving" climate challenges politically powerful in urban areas with large stocks of built capital and socially vulnerable residents (Loughran 2018).

These local and global efforts, in turn, are interweaving with national policies and programs that continue to shift and respond to the growing costs of environmental threats. The federally subsidized U.S. National Flood Insurance Program, for example, has long underwritten and thus encouraged residential development in chronic flood zones (Bagstad et al. 2007). Yet recently, related agencies have begun to offer federally subsidized buyouts of privately owned residential properties in these same areas. Undertaken in every state but Hawaii during the past three decades and funded by the Federal Emergency Management Agency (FEMA), buyouts are voluntary exchanges between a property owner and the government, with the latter seeking to return the purchased lot to its prior undeveloped state, never to be built-on again except perhaps for flood mitigation infrastructure. These transactions embody the current, dominant mode of urban adaptation policy related to environmental migration in the USA. The moves are voluntary, government-funded relocations that are part recovery, part retreat, and fully optional. As such, they offer valuable insight into how government strategies aimed at long-term adaptation intersect with more proximate systems of urban mobility, residential settlement and social inequality in which they remain entangled (Fussell et al. 2014).

From this perspective and despite their association with geographically fixed housing units, buyouts, like many other climate change strategies, are fundamentally about geographic mobility. This point represents a clear departure from how most policymakers and scholars have understood them. Organizationally, FEMA-subsidized buyouts are financed by the Hazard Mitigation Grant Program, which provides funds for local jurisdictions to purchase and clear hazardous properties. According to FEMA, the program's "key purpose … is to enact mitigation measures that reduce the risk of loss of life and property from future disasters" (FEMA 2019: 1). Scholars have therefore approached buyouts as primarily a mitigation program, not a relocation process, with research to date focusing mainly on best practices for increasing local adoption (Fraser et al. 2003; Godschalk et al. 1999). These efforts, including more recent studies of specific communities undergoing buyouts (de Vries and Fraser 2012; Koslov 2016; Lynn 2017), show that buyouts, though framed by policymakers as voluntary, individualized choices, are actually quite complex and involve decisions about not just whether to leave one's home in response to environmental threat but also and importantly, where to go next.

Yet, the question of where people move after they sell their property to buyout programs remains largely unexamined. While rare cases such as New York City's Ocean Breeze neighborhood after Hurricane Sandy offer examples of communities with strong social ties making the collective decision to relocate en masse via a program of "managed retreat" (Koslov 2016), such cases remain outliers for a couple of reasons. First, to the chagrin of many planners, FEMA and local governmental entities often face difficulties in obtaining widespread consent for buyouts from individual owners (Maly and Ishikawa 2013). Second, while much of the funds for buyouts in the United States derive from the federal government, considerable variation in policy implementation exists at the local level, with very few jurisdictions offering relocation assistance (Siders 2018).

Under these general conditions, environmental pushes and assistance from government sources are likely to be necessary but insufficient motivations for relocation. What probably matters as much if not more to homeowners is where they see themselves

resettling. If it is in a more desirable neighborhood, then the buyout is likely to be more attractive because it offsets lost attachments to place. In this scenario, voluntary acts of environmental mobility are best conceptualized not as retreat but pathways to residential attainment. By contrast, if resettlement is likely to lead only to a neighborhood of similar or reduced socioeconomic status, then the buyout is likely to be much less attractive. In this way, where environmental mobility leads powerfully predicts whether it occurs. This understanding rests on the voluntary nature of environmental mobility generally while also opening up research to very real inequalities in the ability of different groups to improve their neighborhood status, even when they own their own homes.

Social inequities, racial segregation, and environmental mobility

Recently, scholars have examined how perceptions of the federal buyout program's "voluntariness" diverge across racial, class, and generational lines (Muñoz and Tate 2016), as well as the ways that communities of color can encounter buyouts as a contemporary form of "urban renewal" that targets them for removal (Lynn 2017; Siders 2018). Other work has found that, at least in Houston, property buyouts have been disproportionately located in areas with high levels of "white flight" in decades preceding government buyouts, and that areas with high levels of racial stability, regardless of which racial group predominates, are less likely to become major buyout areas even in the presence of identified environmental risk (Loughran, Elliott, and Kennedy 2019). These findings collectively point to how buyouts, though technocratically framed and presented as rational solutions to growing environmental risks, can become racialized forms of environmental mobility through their intersection with historical patterns of segregation and lingering inequities among respective households.

One way that such inequities come into play is through the fact that buyouts are limited to property owners, which given the historical marriage of race and real estate in the United States, immediately links to racial-spatial inequality (Gotham 2014; Satter 2009). This history is coupled with racially unequal homeownership rates in the present – a form of stratification further compounded by the fact that homeowners of color hold less home equity than whites, and that homeowners of color experienced greater declines in home equity following the 2008 housing market crash in the U.S. (Taylor et al. 2011). Policymakers' framing of buyouts as "mitigation" obscures these racialized inequities in housing access and assets and instead attempts to position the policy in apolitical terms through its use of cost-benefit analyses to target specific areas, regardless of who lives there. The "voluntary" aspect of the program also serves to obscure its politics, as it privileges individual rights and the idea of "choice," allowing the market, rather than the state, to serve as the final arbiter of post-buyout fortunes. In these respects, buyouts are an archetypal neoliberal, colorblind urban policy (Mele 2013), one that now carries the added existential weight of "saving" cities and their residents from climate change (Loughran 2018).

That said, not everyone who is eligible for a housing buyout chooses to accept it, whether because of a desire to remain in their same home, because the government's offered price is deemed too low to accept because future flood risks are discounted, or

because prospective destinations are deemed unattractive. Indeed, prior studies of post-disaster mobility have indicated that economic factors and levels of property damage are not the prime determinants of individuals' decisions to relocate, but rather local social ties — whether in the form of employment, family and friend networks, or general place attachment — tend to play a stronger role (Chamlee-Wright and Storr 2011; Haney 2018), and that these factors shift in relative importance at different points in the life course (Binder et al. 2015; Cong et al. 2018; Nejat et al. 2018).

For individuals who do accept buyout offers, residential choice sets and preferences vary along racial lines. Sociological work on residential mobility has shown that ethnoracial groups prefer to live among a preponderance of their own group and that preferences to avoid majority-black areas are also particularly strong across groups (Charles 2000; Hwang and Sampson 2014; Meyerhoffer and Kenty-Drane 2018). While no studies to our knowledge have examined these dynamics with respect to environmental mobility specifically, it is reasonable to infer that racialized preferences are present in prospective relocation decisions in no small part because they are also tied to actual and perceived neighborhood status (Bader and Krysan 2015). The implication is that environmental mobility is likely to be strongly influenced by general interests and differential opportunities to engage in upward neighborhood attainment, not just environmental risk reduction itself. These tendencies, in turn, mean that the racial composition of existing neighborhoods is likely to play an integral but hidden role in how such mobility unfolds.

With these ideas in mind, we orient our investigation around three central research questions. First, to what extent do moves from environmentally risky homes lead to nearby (as opposed to far-away) destinations? Second, to what extent does this environmental mobility lead to and thus seem to rely on attaining residence in higher status neighborhoods? And third, to what extent does this residential attainment depend on resettling in neighborhoods that are whiter in composition than those left behind? If our findings indicate that environmental mobility depends on racialized processes of neighborhood attainment, it would challenge a purely technocratic framing of current buyout policies while also illuminating the racialized nature of environmental mobility.

Data and methods

Data to test these hypotheses and to affirm the local nature of environmentally motivated relocation generally were assembled as follows. First, we obtained a database of all federally funded residential buyouts administered by the Harris County Flood Control District (HCFCD) between January 2000 (when the local program began in earnest) and August 2017 (just before Hurricane Harvey). The HCFCD is the governmental entity that manages property buyouts in Harris County, Texas, which is the central county of the Houston metropolitan area and largely coterminous with the City of Houston boundaries. This database contained 3076 records with each property owner's name, lot size, price of buyout, and date of formal execution.

To convert these place-based records into mobility data, we took several steps, as indicated in Table 1. To start, we excluded records in which the buyout property was owned by a corporate entity rather than by an individual homeowner ($n = 157$). We then excluded records in which the site had no structure present at the time of the buyout,

often in a planned subdivision where buyouts occurred before homes were actually built ($n = 412$).[3] Next, we excluded records with clerical errors that compromised data quality ($n = 141$), which included mostly duplicate entries and some entries with no property owner names, which made tracking subsequent destinations impossible.

These steps left us with a database of 2366 valid records for which to search for destination addresses. Using name and address information from those buyout records, we first turned to the online database of the Harris County Appraisal District (HCAD) for Tax Year 2018, which is searchable by name and includes ownership histories for each property. If there was an exact match for the bought-out owner's name in the HCAD database and the timing of entrance into the new recorded residence roughly matched the buyout date, then the new address was inputted as the buyout destination. Next, to affirm data quality and track names that did not appear in the HCAD database, we turned to the online database FastPeopleSearch.com, which allows users to conduct a public records search by individual name and then returns all addresses ever affiliated with that person, including those they may have rented. We then used a second online database, Anywho.com, to further identify and verify respective destination addresses. If an address for the bought-out owner could not be reliably located and verified, we treated them as missing ($n = 584$). This number includes $n = 211$ cases in which names in the buyout database were common enough (e.g., Pedro Martinez and Carol Moore) to create ambiguity in identifying the next address.

Next, to each non-missing record, we appended 2000 Census data on the demographic composition of origin and destination neighborhood. We use 2000 data because observed buyouts span from 2000 to 2017, and we want to ensure that measured socioeconomic conditions at origin and destination come at the same time, as well as at the start, not end, of the relocation window.

While the resulting dataset is unique in tracking destinations for a large number of buyout participants across many different buyout zones in a single urban area, one limitation is that it lacks information on the racial and ethnic identities of program participants. We take two steps to address this limitation. First, we use a list of the hundred most common Spanish surnames to approximate Hispanic ethnicity.[4] While this method is imperfect, it still offers a reasonable means of running robustness checks on our analyses and interpretations. Second and relatedly, rather than focusing on the race of individual property owners, we focus on the racial composition of origin and

[3] These cases were deduced from addresses of properties that begin with "0," for example, "0 Little Fox, Lot 18." It was further verified by use of Google Earth imagery.

[4] The use of Spanish surnames to infer various forms of Hispanic identity has a long and complicated history in the United States, in both governmental and social-scientific endeavors (Dávila 2001; Rodríguez 2000). Not everyone with a Spanish surname identifies as Hispanic, and not everyone who identifies as Hispanic has a Spanish surname. The latter point is particularly true in Texas, which was once part of Mexico and is home to multiple generations of Mexican Americans (San Miguel and Guadalupe Jr 2001). Prior studies indicate that this method of approximating ethnoracial identity via surnames is certain to undercount the total number of Hispanics in the population under study, but that people with Spanish surnames are strongly likely to self-identify as Hispanic (Stewart et al. 1999: 1065; see also Rumbaut 2009: 8). We certainly do not wish to "impl[y] that the community [does] not include Mexican Americans with surnames that [do] not sound Spanish" (Mora 2014: 54). Rather, in the context of our data's limitations, we simply hope to approximate the number of Hispanics in our analytic sample to confirm that we are not disproportionately excluding Hispanic movers, given our inability to find destination addresses for all property owners in the buyout program (see Table 1).

Table 1 Total counts and analytic sample of federally funded buyouts in Harris County, TX

	Count	% of (Sub)Total
Total number of buyout records[a]	3076	100.0
Minus undeveloped sites with no housing structures ($n = 412$)	2664	86.6
Minus corporate owners ($n = 157$)	2507	81.5
Number of developed, non-corporate sites	2507	100.0
Minus records with clerical errors ($n = 141$)	2366	94.4
Number of developed, non-corporate sites with valid data	2366	100.0
Minus unlocated owners ($n = 584$)	1782	75.3
Analytic sample: located buyout participants (aka, environmental movers)	1782	100.0
(Number of census tracts of origin)	(129)	
[Number of census tracts of destination]	[711]	

Source: Harris County Flood Control District Records

[a] Before Hurricane Harvey, August 2017

destination neighborhoods and the social dynamics of environmental mobility they help to reveal.

With these methods, we successfully identify the relative distance as well as the socioeconomic conditions for origin and destination neighborhoods for 1782 bought-out property owners, representing 75% of households who accepted a buyout in Harris County prior to Hurricane Harvey in 2017. The 584 cases for which we failed to determine a post-buyout address present a potential limitation in our analysis, as it is possible that these unobserved movers relocated longer distances or otherwise embodied different types of moves than the average movers in our sample. We assess this potential bias below.

Assessing sample bias

To test for bias in our analytic sample, we start with the full sample of 2366 developed, non-corporate buyout sites with valid administrative data. With this sample, we estimate a simple logit model in which the outcome equals one if we found the buyout participant's destination address, and zero if we did not. The predictors include whether the owner had a Spanish surname (our proxy for Hispanic identity) as well as the price, acreage, and number of days since the buyout transaction was formally executed, which we log-transform to achieve a more normal distribution. In addition, we also include the racial and class characteristics of the census tract in which the buyout occurred, measured using decennial census data from the year 2000. Because in some cases multiple buyout properties were located in the same census tract, we estimate the model using robust standard errors to account for such clustering.

Results in Table 2 indicate that our analytic sample tends to disproportionately exclude larger, less expensive properties, which we interpret to lie largely outside the urban core where population densities generally drive lot size down and property values up. Reassuringly, results also show that a host of other factors do not predict

Table 2 Logistic regression results predicting inclusion in our analytic sample (with robust standard errors in parentheses)

Buyout property characteristics	
Last owner has a Spanish surname	.136 (.145)
Buyout price ($, logged)	.386* (.162)
Buyout acreage (logged)	− .342* (.162)
Days from buyout (logged)	− .085 (.150)
Buyout tract characteristics in 2000	
% Black	−.073 (.645)
% Hispanic	.191 (.883)
% Asian	5.536 (5.579)
Income per capita (logged)	.162 (.625)
% Owner occupied	1.361 (.691)
Constant	−5.972 (6.430)
N (Buyout sites)	2366
Wald chi-square	12.29

*$p < .05$; two-tailed tests

exclusion from our analytical sample. These include whether the owner has a Spanish surname, as well as the amount of time since the buyout was executed, in addition to the racial, income, and homeownership composition of the tract in which the buyout occurred. Thus if we find subsequent variation along these lines, we can be reasonably confident that it is not due to selection bias. Still, there could be other unobserved sources of selection bias at work, including the choice to redact personal information from local public records in ways that make it difficult to identify destination addresses, and personal attributes that make tracking one's residential moves difficult, such as immigrant or undocumented status and moving into an existing household where one's residence is not readily recorded in public records.

Results

Local environmental mobility

To begin, we assess the extent to which environmental relocation via buyouts leads to resettlement within the local area. In Table 3, we use our analytic sample of 1782

Table 3 Relocation patterns for environmental movers ($n = 1782$)

% Staying in same tract	4.8
% Staying in Harris County	78.8
% Staying in Metro Houston	89.7
• Mean distance moved within metro (miles)[1]	12.7
• Median distance moved within metro (miles)	9.2
% Within 100 mi or less of origin address	92.5

[1] Mean and median distances are calculated as straight-line distance from origin to destination address.

owners for whom we found destination addresses. Of these, the majority left the tract in which their buyout property was located (95%) but stayed within the same county (79%). If we extend this local geography from the encompassing county to the entire (nine county) metropolitan area or to a 100-mile radius, the share of "local" moves increases to roughly nine out of ten identified cases in both scenarios. Thus, even if we made the radical assumption that all homeowners we failed to locate ($n = 584$) were still alive and had resettled outside the metropolitan area, those moving *within* the metro area would still outnumber those who left by roughly two to one ($584 + 186 = 770$, compared with 1596). These findings support what we might expect from classic migration theory (Ravenstein 1885) as well as recent empirical research on residential mobility more generally (Crowder and South 2008), namely that most moves — including those voluntarily undertaken in the face of publicly acknowledged environmental risk — are local. This means they are less about long-distance relocation than population redistribution among nearby neighborhoods and towns.

Next, to determine if types of neighborhoods are more prone than others to local environmental moves, we estimate a simple logistic regression model for all cases with valid destination data ($n = 1782$). In this model, staying local is defined as relocating within the metro area (1 = yes; 0 = no), and tract-level predictors are the same as those in Table 2. Results appear in Table 4 and indicate that the odds of making a local versus nonlocal move increase with the percentages of black and Hispanic residents in the buyout tract ($p < .05$). Specific calculations show that, all else equal, the predicted probability of staying within the metro area increases from 90 to 96% as the share of black residents in the buyout tract increases from 20 to 80%. For Hispanics, the predicted probability of staying within the metro area increases from 87 to 95% over the same range, that is, from 20 to 80% Hispanic. By comparison, the predicted probability of staying in the metro area is only 77% in exclusively white buyout tracts (predicted by setting all other racial composition variables in Table 4 to zero). The implication is not just that minority neighborhoods tend to experience more local environmental mobility than white neighborhoods. It is also and by extension that analyses excluding local environmental mobility discount the environmental migration of neighborhoods of color.

Environmental mobility within the same neighborhood

Next, we examine which types of neighborhoods tend to retain environmental movers, despite publicly identified flood risks. Here, we restrict our analysis to environmental

Table 4 Logistic regression results predicting relocation within the metro area

Buyout tract characteristics in 2000	
% Black	1.544* (.614)
% Hispanic	1.873* (.744)
% Asian	1.673 (2.985)
Income per capita (logged)	.001 (.001)
% Owner occupied	.674 (.467)
Constant	.281 (.714)
N (buyout sites)	1782
Wald chi-square	10.03

*$p < .05$; two-tailed tests

movers who resettled within the local metropolitan area because we are interested in where local movers relocate. We then estimate two logit models (with robust standards based on tracts of origin) in which the outcome equals one if the environmental mover relocated to somewhere else in the same tract and zero if they relocated elsewhere in the metropolitan area. For Model A of Table 5, we include percent black, Hispanic, and Asian respectively for our measures of racial composition in the buyout tract. For Model B, we substitute a simple measure of percent white for these measures.

Results from both models yield a consistent picture: the only factor that significantly predicts an environmental mover resettling within the same tract as their buyout property is the tract's racial composition. Specifically, the higher the percentage of white residents, the greater the odds of staying in the same neighborhood. All else equal at their sample means results of Model B indicate that the predicted probability of staying in the same tract increases from 2% where whites comprise just 20% of residents to 12% where they comprise 80% of residents.

Next, we extend our analysis to examine the likelihood of environmental movers resettling in any buyout tract, not just their own. Because this outcome is conditional on staying within the same county (where we have data to reliably identify buyout tracts), we limit analysis here to those who relocated within Harris County (79% of our analytic sample). Using the same predictors as above, logistic regression results in Table 6 indicate that environmental movers from whiter tracts are not only more likely to stay in the same tract as their buyout property, they are also more likely to resettle into buyout tracts more generally, wherever those tracts are located. For example, calculations from Model B of Table 6 indicate that all else equal, environmental movers from tracts that are 80% white resettle into buyout tracts 45% of the time. This compares to just 29% of the time for environmental movers from tracts that are only 20% white. Moreover, this tendency increases with shorter moves. Both findings imply that the whiter, or more racially advantaged, the buyout area, the more likely

Table 5 Logistic regression results predicting an environmental move within same census tract (with robust standard errors in parenthesis)

	Model A	Model B
Buyout property characteristics		
Last owner with Spanish surname	− .089	− .132
	(.487)	(.493)
Buyout price (logged)	− .086	− .104
	(.095)	(.101)
Buyout acreage (logged)	− .229	− .169
	(.270)	(.272)
Days from buyout (logged)	.539	.661
	(.381)	(.396)
Buyout tract characteristics, 2000		
% Black	− 2.395*	–
	(1.180)	
% Hispanic	− 4.860**	–
	(1.641)	
% Asian	− 2.087	–
	(5.906)	
% White	–	2.890*
		(1.435)
Income per capita (logged)	− 1.666	− .970
	(.970)	(.843)
% Owner occupied	.497	− .338
	(1.220)	(1.035)
Constant	11.199	.827
	(9.395)	(7.071)
n (movers w/ known destination in metro)	1526	1526
Wald chi-square	12.08	7.04

* $p < .05$; ** $p < .01$; *** $p < .001$; two-tailed tests

environmental movers are to relocate within them or to them despite publicly identified environmental risks.[5]

Findings from Models A and B of Table 6 reveal other significant predictors of resettling within a buyout tract. In terms of standardized effects, the strongest predictor is time since the buyout was formally executed (measured as the logged number of days between the date of execution and January 1, 2018). Here the positive coefficient indicates that buyouts executed further in the past were more likely to lead to other buyout areas, with that tendency now diminishing over time, perhaps as related risks become more evident with repeated flood events. In addition, results indicate that

[5] To further clarify, census tracts that are home to property buyouts are not a perfect proxy for local flood risks, as flooding can occur outside federally designated flood plains where buyouts are geographically targeted and because acceptance of buyouts is subject to social factors such as neighborhood composition (Loughran et al. 2019). However, any tract that does have a buyout property can reliably be considered to be an area of repetitive flood risk, as this is a precondition for implementation.

Table 6 Logistic regression results predicting an environmental movers' resettlement in a buyout tract (with robust standard errors in parenthesis)

	Model A	Model B
Buyout property characteristics		
Last owner with Spanish surname	.241*	.251*
	(.118)	(.116)
Buyout price (logged)	− .161*	− .172*
	(.076)	(.082)
Buyout acreage (logged)	.201	.223
	(.116)	(.121)
Days from buyout (logged)	.465***	.482***
Buyout tract characteristics, 2000	(.104)	(.105)
% Black	− 1.196**	–
	(.359)	
% Hispanic	− 1.444**	–
	(.551)	
% Asian	− 5.437*	–
	(2.416)	
% White	–	1.221**
		(.370)
Income per capita (logged)	− .773*	− .834
	(.307)	(.278)
% Owner occupied	.368	.382*
	(.422)	(.353)
Constant	5.806	4.981*
	(2.993)	(2.449)
n (movers w/ known destination in Harris Co.)	1344	1344
Wald chi-square	53.76	48.41

* $p < .05$; ** $p < .01$; *** $p < .001$; two-tailed tests

owners with Spanish surnames and those receiving less money for their property are also more likely to relocate to (other) buyout areas, which also tend to be less affluent.

Pulling these findings together suggests that there are two general pathways to resettlement into areas of known environmental risk and government intervention. One pathway involves environmental movers from whiter neighborhoods resettling within the same neighborhoods despite identified flood risk, perhaps to retain the social benefits of those whiter neighborhoods, such as higher quality schools and green spaces, as well as ties with neighbors. The other pathway entails Hispanic owners of more modest homes in lower-income neighborhoods moving among environmentally risky tracts, perhaps to take advantage of new housing opportunities opened by local outmigration from nearby environmental risks.

Environmental mobility and neighborhood attainment

Next, we examine the relative socioeconomic status of origin and destination neighborhoods linked by environmental mobility. Our thinking is that, even in the face of

obvious flood risk, people are unlikely to move without a plan of where to relocate next as well as an assessment of how that destination is positioned not just geographically but socially. One way to probe that assumption is to ask if such moves generally lead to neighborhoods of higher or lower socioeconomic status.

To answer this question, we start by comparing the average values of socio-economic indicators in tracts of origin and destination for all environmental movers who stayed within the metropolitan area. Results in Table 7 (using Census 2000 data to maintain a common point of comparison at the start of our observed buyout period) indicate a clear pattern of neighborhood upgrading. For example, per capita incomes increased from an average of just over $19,000 at origin to nearly $23,000 at destination (in 2000 dollars). Similarly, median housing values rose 32%, with shares of owner-occupied housing and non-poor residents also rising. T-tests confirm that all reported differences in Table 7 are outside of the margins of error at the .05-level. As a robustness check and to see if these patterns are restricted (mainly) to whites, we re-calculated the same statistics just for movers with Spanish surnames. Again we find the same general patterns of neighborhood upgrading.

Next, we compute change scores between origin and destination tracts for respective indicators of socioeconomic status for each environmental mover. In this way, we can analyze what factors, if any, contribute to greater neighborhood upgrading along socioeconomic lines and thus possible motivations for accepting a buyout. For this analysis, we estimate a series of simple regression models (with robust standard errors

Table 7 Mean socioeconomic and racial traits of buyout tract and destination tract

	Census 2000 Data		
	Buyout tract	Destination tract	Ratio (dest./buyout)
All located buyout owners in metro Houston ($N = 1596$)			
Income per capita ($)	19,040	22,767	1.20
Median value of owned housing units ($)	77,245	101,667	1.32
% Owner-occupied housing	0.67	0.69	1.03
% Not in poverty	0.85	.92	1.08
% White	0.44	0.59	1.34
% Hispanic	0.34	0.23	0.68
% Black	0.17	0.13	0.76
Located buyout owners in Metro Houston with Spanish surnames ($n = 302$)			
Income per capita ($)	17,093	20,989	1.23
Median value of owned housing units ($)	67,004	93,544	1.40
% Owner-occupied housing	0.66	0.69	1.05
% Not in poverty	0.83	0.90	1.08
% White	0.38	0.52	1.37
% Hispanic	0.41	0.28	0.68
% Black	0.17	0.13	0.76

based on tracts of origin). For each model, the dependent variable is the respective change score, say, in income per capita from origin to destination, with more positive scores indicating greater neighborhood upgrading. Predictors include the price and timing of the buyout, as well as the racial composition of the tract of origin and destination, measured here simply as percent white.

Results in Table 8 reveal the same clear pattern for changes in income, median home values, percent homeownership, and percent non-poor. Namely, the amount of buyout money received for one's property has little effect on neighborhood upgrading. Instead, what matters is the racial composition of one's origin and destination tract. Specifically, the whiter one's origin tract, the more one is likely to downgrade in neighborhood socioeconomic status at destination unless one is able to resettle into a tract of equal or greater white composition. Indeed, this is the key predictor of neighborhood attainment. Supplemental analyses indicate that this pattern holds even after controlling for whether the destination tract is also a buyout area, implying that environmental movers are keener to upgrade or otherwise maintain higher neighborhood status than they are to avoid areas prone to repetitive flooding and government intervention. As a robustness check, we again re-estimated the same models only for movers with Spanish surnames. These supplemental results (available upon request) show the same general pattern; it is not restricted to or driven solely by white movers.

Table 8 Linear regression results predicting change in socioeconomic status from origin to destination tract for environmental movers resettling in the nine-county Houston Metro area

	Δ Per capita income ($)	Δ Median value of owned housing units ($)	Δ % Owner-occupied housing	Δ % Not in poverty
Buyout property characteristics				
Buyout price (logged)	−392.10	−407.28	−.016	−.001
	(518.06)	(2324.28)	(.014)	(.003)
Days from buyout (logged)	−1173.96*	−4129.62	−.018	−.021
	(454.55)	(3203.79)	(.039)	(.009)
Buyout tract characteristics, 2000				
% White	−22,220.58***	−76,394.77***	−.493***	−.295***
	(1337.00)	(10,584.66)	(.097)	(.023)
Destination tract characteristics, 2000				
% White	24,016.99***	100,003.6***	.388***	.233***
	(1071.04)	(5809.86)	(.034)	(.011)
Constant	13,974.88	39,203.38	.328	.236
	(8215.41)	(40,831.99)	(.365)	(.088)
N	1523	1523	1523	1523
R^2	.490	.304	.264	.583

* p < .05; ** p < .01; *** p < .001; two-tailed tests

Sample includes all located buyout owners who remained in metro Houston ($n = 1596$), minus 73 cases (< 5%) for which data on one or more variables is missing (mainly for days from buyout)

Discussion & conclusion

Humans have long used geographic mobility as an adaptive strategy for migrating extended distances but also for moving shorter distances within their local metropolitan area. To the extent that social scientists have studied these shorter moves, they have highlighted processes of neighborhood attainment in the midst of economic and racial segregation but ignored environmental factors pertaining to natural hazards. Those times are changing, driven not just by the rising costs and frequency of urban flooding and sea level rise but also by government programs designed to remove homeowners and their properties from harm's way en route to building more "resilient" cities.

To date, efforts to investigate this type of environmental mobility have been limited, and thus the present study has remained modest by design. Our efforts involved gathering data on thousands of federally funded buyouts of residential properties across many different areas of a major urban center. We then extended outward from each of these buyout sites to track for the first time where respective homeowners moved, in addition to linking census data to origin and destination neighborhoods to better understand the residential pathways taken. Along the way, we advanced two key points often downplayed in the literature on environmental migration. First, decisions to voluntarily relocate from environmentally risky areas are likely to depend a great deal on where residents envision ending up. Second, where they envision ending up is likely to be informed not only by desires to stay within the same local area but also by racialized processes of neighborhood attainment that challenge a purely technocratic framing of current buyout policies and environmental mobility more generally.

So what did we find empirically? First, residential relocation from imminent environmental threat is indeed a very local process, at least in the United States. Not only did 90-plus percent of buyout participants we found stay within the Houston metropolitan area, they moved a median distance of less than 10 miles. Even if we allow for the possibility that all homeowners we failed to locate migrated outside the metropolitan area, those relocating within it would still outnumber those longer-distance movers roughly two to one, with supplemental analysis indicating even higher rates of local mobility in and from neighborhoods of color.

Results also indicate that most homeowners tend not to undertake environmental mobility unless they can maintain or increase the socioeconomic status of their new neighborhood, which is tightly linked to its racial composition. For residents of environmentally risky neighborhoods that are already predominantly white, this tendency means a higher likelihood of relocating within the same flood-prone neighborhood or moving to another neighborhood that also has publicly identified flood risks. For residents of minority neighborhoods, this pathway is more likely to mean leaving their neighborhood for a whiter one. In other words, what appears to be driving environmental mobility is less the environmental push of imminent risk than the social pull of "upgrading" the socioeconomic status of one's neighborhood and by extension, its racial composition.

If we were to extrapolate these findings further, we might theorize the following general dynamics: Environmental risks and government programs designed to address them are insufficient in and of themselves to remove people

and property from harm's way. For that removal to occur, it must conjoin with opportunities to improve one's neighborhood status through the usual market means and within existing patterns of neighborhood inequality. Under such conditions, the higher the socioeconomic status of one's neighborhood, the fewer those opportunities will be, which most likely means staying put and purchasing more publicly subsidized insurance from the National Flood Insurance Program. By contrast, the lower the socioeconomic status of one's neighborhood, the greater those opportunities will be, in which case taking the buyout and moving elsewhere will be more attractive, if one can afford it. As a result of these dynamics, more privileged neighborhoods are likely to continue drawing disproportionately from federal insurance dollars, while less privileged neighborhoods are likely to lose more and more homeowners — and with them, residential tax dollars — as buyout properties are demolished and returned to nature for mitigation purposes.

Here again, it is important to note that our analyses focus just on homeowners because that is where the U.S. federal government targets it environmental mobility assistance. In privileging homeowners through a market-centered, voluntary policy, the federal buyout program does not address the environmental mobility of more vulnerable urbanites who rent rather than own their housing and thus are more likely to move as natural hazard damages increase (Elliott and Howell 2017). Those moves, we suspect, would be less voluntary because they include less agency and assistance, and thus deserve their own directed research. Still, in the "colorblind," neoliberal context of U.S. urban policy, it seems evident that urban adaptation to current and future environmental risks will remain disproportionately shaped by market-centered policies that cater to already-privileged groups. Ultimately, what is portended by such an approach is a strategic pivoting within urban areas, where public subsidies, acting in the name of lowering environmental risks, sacrifice certain hazardous areas in the name of the "greater good" – to the benefit of white homeowners and those otherwise privileged enough to live in communities where such individuals predominate.

In offering these insights, we hope the present study has amplified the call for new, more environmental approaches to urban studies and residential mobility. Older approaches, which abstract away the physical environment of cities, require critical updating in the time of climate change. Certainly, theories of urbanization that foreground market forces, racism, the state, culture, and the political economy of place-making still hold value because these forces continue to organize social space and residential movements within it. But, if past efforts could ignore the environmental forces that have shaped the material conditions of cities all along, this is an ontological "luxury" that we can no longer afford. The socio-environmental transformations that accompany increasing natural hazard damages demand social scientific investigation by researchers equipped with understandings of racial-spatial change, residential mobility, and other urban processes. Identifying how new and existing environmental concerns shape these processes will produce the kind of environmentally attuned research that can respond to the conceptual, empirical, and policy challenges brought by climate change. We look forward to those ongoing efforts.

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