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# At the Water's Edge: Coastal Settlement, Transformative Adaptation, and Well-Being in an Era of Dynamic Climate Risk

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## Keywords

coastal communities, dynamic risk and response, stressors, well-being, climate adaptation

## Abstract

With accelerating climate change, US coastal communities are experiencing increased flood risk intensity, resulting from accelerated sea level rise and stronger storms. These conditions place pressure on municipalities and local residents to consider a range of new disaster risk reduction programs, climate resilience initiatives, and in some cases transformative adaptation strategies (e.g., managed retreat and relocation from highly vulnerable, low-elevation locations). Researchers have increasingly understood that these climate risks and adaptation actions have significant impacts on the quality of life, well-being, and mental health of urban coastal residents. We explore these relationships and define conditions under which adaptation practices will affect communities and residents. Specifically, we assess climate and environmental stressors, community change, and well-being by utilizing the growing climate change literature and the parallel social science literature on risk and hazards, environmental psychology, and urban geography work, heretofore not widely integrated into work on climate adaptation.

## INTRODUCTION

Nearshore coastal communities are highly dynamic sites. Physical processes, including continuous weathering and erosion, and extreme events, such as coastal storms and flooding, heighten the prospect that these communities have to actively work to maintain property values and livelihoods. As a result, coastal US cities have experienced many significant challenges owing to loss and damage from disasters and ongoing sociopolitical debates about recovery and short- and long-term response options (5, 45).

Climate change is exacerbating these risks in coastal US cities by strengthening extreme storms and accelerating sea level rise (SLR), which together create a greater probability of catastrophic flooding events as well as incremental sunny day flooding (i.e., mean monthly high tide flooding). These conditions are placing pressure on municipalities and local residents to consider a range of new disaster risk reduction programs, climate resilience initiatives, and, in some cases, relocation strategies (e.g., managed retreat from highly vulnerable, near-shore, low-elevation locations). These more substantial climate risks and climate adaptation actions have varying and significant impacts on the quality of life, well-being, and mental health of urban coastal residents.

At the same time, the number of residents in the nation's coastal communities is growing (42). Population counts in the 2010s revealed that 123 million people (39% of the US population) lived in coastal counties (142). Urban expansion is rapidly moving into flood-prone areas of many coastal US metropolitan regions such as Houston, Miami, New York City, Los Angeles, and Seattle, with Miami having the largest amount of urban extent at low, flood-prone elevations (84). Many disadvantaged communities that are located in these low-elevation coastal zones are at risk from environmental and climate hazards such as SLR and flooding (109, 114).

The mix of increasing climate risk and complex and growing population conditions in coastal communities brings the potential for more debate regarding coastal development and the future habitability of at-risk, near-shore sites and the well-being of their residents. More than a decade ago, scholarly writing began to appear that described the potential psychological effects of heightened climate change impacts on coastal communities and their inhabitants. This literature presented opinions on and scenario-based assessments of the expected economic and psychological challenges that communities will face with accelerating SLR, increased flooding, and inundation. A central theme of this research was on the loss of sense of place and associated psychological stress.

It has now become clear that the future projected in this early literature has become or will soon become reality. Communities and states throughout the United States are openly discussing the growing costs of protecting the shoreline, including large-scale resiliency efforts and in some cases managed retreat scenarios (49). Residents and businesses in these communities face the prospect of increasing risk, loss of sense of place, and psychological stress from having to reimagine their homes and neighborhoods as well as the possible need to relocate. The need to understand the pressures that these communities will endure has never been greater as empirical examples can now take the place of scenario-based and forecast-based assessments.

One central objective of this article is to review and assess the early literature on climate change and communities as well as newer empirically based studies. Although this literature is still relatively nascent, a much broader literature does exist on how community dynamics result in challenges to residents' psychological well-being. This research is deeply connected to a variety of issues within the social sciences, especially disaster and hazards analysis, environmental psychology, and urban geography and planning studies. This research heretofore has not been fully integrated into the climate change and community literature. An often-made critique of the climate change inquiry is that it emerges in isolation from the broader social science literature on topics of related focus and interest. This review provides some of that integration. A second key objective of this article is to review and assess the broader social science literature on community transformation

and well-being through a lens relevant to dynamic coastal risk and climate change. This analysis will help us present several key areas of research and knowledge gaps.

To address these objectives, the review is organized as follows. First, we briefly discuss how conditions of dynamic coastal risk and adaptation are impacting communities and residents' quality of life and well-being (see the section titled Dynamic Climate Risk and Hazards in the Urban Context). Next, we assess the early and current climate change and community change literature (see the section titled Climate Stressors and Community Change). The fourth section (see the section titled Urban Environmental Stressors, Community Change, and Well-Being) reviews and assesses the parallel disasters and hazards, environmental psychology, and urban geography and planning research relevant to community dynamics and well-being. The goal of this review is to assess relevant social science findings to determine how they can inform our understanding of the potential emotional and psychological effects of dynamic climate risk and the resulting transformative climate adaptation actions now being discussed in coastal US communities (see the section titled Transformative Adaptation Responses to Dynamic Urban Coastal Climate Risk). This final section advances public health research by determining gaps in current considerations and informs public health strategies that can be integrated into place-altering adaptation efforts such as managed retreat and relocation.

## **DYNAMIC CLIMATE RISK AND HAZARDS IN THE URBAN CONTEXT**

Urban areas and their populations face a variety of risks and hazards. Some reflect the landscapes onto which the structures of cities and communities are built, such as steep slopes, low-elevation water's edge sites, and earthquake-prone locations, among other hazards. The character of risks and hazards is often exacerbated through urbanization and the alteration of the local environment (e.g., creation of impervious surface increasing the flood risk) as well as patterns and organization of human settlements (i.e., located in frequently flooded areas). In this way, cities are in a state of constant becoming, where there are rapid shifts in the social, ecological, and technological systems that both create and recreate cities as well as shifts in their exposure and vulnerability to risks and hazards (36, 72, 164). The urban context is a rich space in which to study the complexity of climate risk and response owing to the extensive and rapid alteration of the physical environment. Modifications to the natural environment include building construction, infrastructure development, and land use change. Advances in early-warning storm predictions and storm-resistant construction have in many cases resulted in declines in storm-related injuries and deaths, while at the same time encouraging more construction in at-risk coastal sites (134).

Disaster risk studies in urban environments have shown that urbanization shapes a city's capacity to adapt to and respond to risk and shapes current and future vulnerabilities (73, 96, 146, 179). Much of this work focuses on what kinds of vulnerabilities are produced from social, ecological, and technological risk (165). Technological risk includes placement of hazardous waste and industrial sites near dense residential areas (15). Ecological risk includes coastal land use changes that degrade coastal ecosystems and increase flooding (144, 149). Social risk includes placement of dense populations in areas prone to flood hazard, such as low-lying coastal areas (52). Studies of the effects of urbanization on vulnerability have revealed how social contexts shape how populations are affected by urban planning and policies, especially when it comes to adaptation planning in urban areas (64, 139, 151).<sup>1</sup>

The rate at which coastal cities are growing because of urbanization is increasing cities' overall exposure to flood risk (106). For instance, the growing density of communities in low-elevation,

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<sup>1</sup>For instance, institutional capacities and resources affect the availability of personnel as well as the resources to plan for risk reduction (23). In addition, researchers have argued that governance is needed to coordinate

flood-prone areas is being compounded by increasing risk from changes in frequency and intensity of intense precipitation events (i.e., heavy downpours) (53). The dynamism of urbanization means that urban environments' risks and hazards are constantly changing, which in turn requires community responses that are flexible and constantly evolving (128, 167).

Risks and hazards affect community quality of life in several ways. Direct loss and damage result in community stress and crisis immediately following an event or in a period of protracted recovery (95). In some cases, the impacts are also perception based in that the potential of a future hazard event shifts the patterns of everyday life in the community through changes in people's behavior or shifts the patterns of investment and economic practice (177). Extreme events, in some cases, can directly cause displacement of residents and contribute to community transitions if the residents are displaced because of a disaster or are displaced because of adaptation decisions that include managed retreat (54).

Displacement of communities has been studied across the social sciences through the lens of place identity—the sense of belonging to a specific place, which can be mediated by dynamic city environments and their associated stressors (104). Place identity can take longer to establish than emotional bonds (i.e., place attachment). This condition is especially relevant to coastal communities where population mobility creates a community of permanent and seasonal residents (136). In relation to risk of flooding and SLR (see **Supplemental Figure 1**) in coastal communities, the social sciences literature has focused specifically on place attachment to describe how communities and residents ascribe meaning to place, which can influence their reaction to changes in the urban environment and community structure under conditions of stress (e.g., gentrification, transformative adaptation) (3, 133).

To understand this relationship, it is important to recognize first that psychological well-being is connected to one's sense of place attachment and affinity. Second, social identity shapes one's experience with risk and how one assigns risk in local places (21, 55). In this way, how one cares about aspects of their environment affects their decision-making relative to risks within that environment (147). Displacement from disaster or decisions to relocate communities in response to hazards create a loss of sense of place, affecting emotional attachment to place and shaping responses to adaptation decision-making (67, 85). Therefore, strong place attachment affects individual willingness to cope with flood risk (50).

A critical new area of research has emerged to examine these connections and focus on cascading risks and linkages between household and community impacts and community transitions (101, 130, 131). This research studies risk as forms of destruction across communities and households and across different types of well-being issues related to social, cultural, and environmental contexts (129). Specifically, this literature has studied coastal vulnerability from the point of view of exposure and sensitivity to hazards or the contextual vulnerability.<sup>2</sup> Aspects of these connections are further explored in the next two sections of this article.

## CLIMATE STRESSORS AND COMMUNITY CHANGE

Literature of climate change vulnerability impacts and adaptation first emerged in the 1990s and coalesced in the 2000s into varying interlinking sub areas. Research on climate change as a stressor

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actions and policies between different agencies and actors across multiple levels (household, community, government) to build the capacity to cope with hazards (30).

<sup>2</sup>Context vulnerability focuses on how risk intertwines with the current social environment, including who is affected by the hazard, how they are affected, and why they are affected.

emerged during this time. A central tenet of this scholarship is that climate change affects how coastal communities experience and respond to risk. The Intergovernmental Panel on Climate Change (IPCC) in the Fifth Assessment Report (AR5) defined stressors as events and trends, often not climate related, that can have an important effect on the exposed system and can increase vulnerability to climate-related risk (93).

Climate change can be considered a type of continuous or ambient stressor for coastal communities, where changes are perceived as subtle along with other biophysical variations of the coast (138). Understanding climate change as a continuous stressor has been contextualized within global environmental change literature as driving incremental environmental changes on the coast that include chronic hazards related to coastal erosion, salinization of freshwater resources, and SLR (66). These events are slow moving, but their effects can accumulate over time, promoting potential disaster for coastal communities (159, 181). Incremental stressors from climate change have impacts on well-being by contributing to a lost sense of place, diminution of social ties through climate migration (170), and anxiety and stress over conflict of increasingly scarce resources (16). The slow-moving rate of these environmental changes affects how coastal communities perceive risk, most commonly forcing the perception that future generations will experience risk and the present generation will not (41, 102).

Detailed empirical research has examined the conditions under which incremental stressors affect community well-being, with many studies looking at the long-term effects of SLR on community relocation and lost sense of place. Research on SLR and community relocation in the United States has mostly focused on tribal communities. The close relationship that tribal communities have with environmental resources has allowed researchers to examine the connections between the disappearance of the natural environment and the social, cultural, and physical well-being impacts of climate change (28, 31, 78). Findings show that SLR combined with other environmental stressors are forcing many tribal communities to relocate, resulting in land loss that creates a lost sense of place and severed social and cultural ties (39).

Within the United States, studies have focused mostly on tribal communities in Louisiana and Alaska. In Isle de Jean Charles, Louisiana, 75% of the community's land has been lost to SLR, oil development, coastal erosion, and changing waterways (32, 87). The Native American communities within this parish (the Pointe-au-Chien Indian Tribe, and Isle de Jean Charles and Grand Caillou/Dulac Bands of Biloxi-Chitimacha-Choctaw Indians) have experienced forced displacement because of rising sea levels and flooding from Hurricanes Katrina and Rita (in 2005) and Hurricanes Gustav and Ike (in 2008) (107). For these communities, the decision to move is fraught because moving from an island onto the mainland destroys the sense of belonging to a landscape to which residents are highly culturally connected. Residents feel that their quality of life would be lost, and as a result, voluntary relocations are difficult to implement (39, 99).

The Alaska Native villages of Kivalina, Shishmaref, and Newtok have been the most studied with regard to relocation and SLR. These communities are experiencing SLR, coastal erosion, and permafrost thaw, which are reducing freshwater supplies and limiting access between villages; these consequences are negatively affecting the well-being and health of those communities (141). These villages have been further along in the relocation process than those in Louisiana by coordinating with the federal government to fund and plan relocation and disaster mitigation strategies (158). The case studies show that even though attempts have been made to search for suitable relocation sites that serve the communities' needs, this objective has been difficult to achieve. Residents' quality of life is highly connected to a subsistence-based way of living, where day-to-day needs are met mostly by natural resources that are also disappearing from the wider landscape owing to climate change (29).

Another way that climate change stressors affect coastal communities is through acute large-scale events (168, 169). For coastal communities, these events include more frequent and intense hurricanes and extreme flooding. It is in the postevent context where researchers have observed psychological stress, including post-traumatic stress disorder and depression and suicide due to the loss of livelihoods, reduced access to health care, disruption in daily activities, changed environments, and damage to property (94, 103, 116). Acute stressors such as flooding also promote displacement of communities through forced relocation or removal of homes, promoting a lost sense of place and a breaking of social ties, where marginalized communities are most affected (69). In this way, acute stressors affect already existing political, social, demographic, and environmental drivers of the decision-making process of those in an area affected by flood risk (6). According to Doherty & Clayton (57), extreme weather events affect risk perception within impacted communities and change how individuals experience the resulting direct, indirect, and psychological impacts (see **Supplemental Figure 2**).

Most literature on climate change, well-being, and community change is based on individual experience to assess quality of life impacts from specific stressors. A majority of studies either conduct overviews of the general effects of climate change (69, 116, 168, 169) or use particular locations as case studies, making use of surveys and interviews to gauge risk perception and experience with stressors (29, 37, 91, 110, 112, 174). Assessing well-being through this kind of research has proven to be difficult because it is variable across impacted communities (111).

Climate change literature has now begun to question the role of place attachment in influencing risk perception and decision-making within hazard-prone areas of coastal communities (56). Owing to the subjectivity of well-being, researchers have started to use place attachment as an alternative concept to measure the well-being of communities affected by climate change. Investigators use qualitative surveys that ask participants to define the value they assign to particular places (180), and they use a mixed-methods approach that combines surveys with statistical analyses to understand the correlation between place attachment and flood risk (18, 128).

## URBAN ENVIRONMENTAL STRESSORS, COMMUNITY CHANGE, AND WELL-BEING

A rapid expansion of occupancy on the water's edge took place in the early post–World War II era (134). This massive development was propelled by an ambition to increase space for the growing leisure and recreational class and was driven by local developers with the idea that the risk burden of increased coastal development will be shared publicly through federal government infrastructure investments, disaster recovery support, and eventually by federally backed flood insurance (171). Specifically, research has found that these insurance structures have created a moral hazard where individuals and developers will choose to build in hazard-prone areas if insurance is available (43). The availability of subsidized insurance such as the National Flood Insurance Program (NFIP) has been shown to subsidize risky developments and promote repetitive losses in these areas (18). For instance, following Hurricane Hugo in 1989, there was little incentive by insurance companies to mitigate against risk, which encouraged building or fixing damaged structures in the same flood-prone coastal areas of Dade County, Florida, and Myrtle Beach, South Carolina (135).

The development of nearshore coastal communities illustrates the dynamism of places and how they are constantly being built and rebuilt (and in some cases destroyed). Processes of neighborhood and community change in these areas can be considered as types of urban environmental stressors that can be incremental or abrupt (125). This process has resulted in the physical restructuring of coastal communities and, under the conditions of dynamic risk, has produced particular stressors that have significant effect on urban coastal residents' well-being and quality of life (56,

104, 136). An assessment of the literature focused on neighborhood change can contribute to our understanding of what conditions are playing out or will soon play out in coastal sites facing SLR and increased flood frequency and what adaptation plans, policies, and strategies emerge.

## **Abrupt Neighborhood Change and Stress**

Disaster research emerged within the academic fields of geography, sociology, and other social sciences in the 1950s and 1960s, focused mostly on hazards of the natural environment (33) and loss and damages from extreme weather events (92). Over the course of the 1990s, a paradigm shift took place changing scholarly focus from studies of specific hazards to attempts to understand the dynamism and context of disaster (178). Specifically, this work tries to understand what kinds of risk and distributional impacts are produced from interactions between the physical and social environments (24), the conditions that create place-based vulnerabilities for communities (45), and ways to improve the capacities of communities to cope with disaster (44).

A key distinction within urban geography literature regarding the character of social, emotional, and psychological impacts of environmental stressors is related to the rate of change that takes place. Abrupt community change can occur from rapid-onset disasters and sudden social unrest (175), while more gradual change can result in deep-rooted and longer-lasting socioeconomic inequality across communities (20, 83). Early on, disaster research illustrated how the emotional and psychological trauma of sudden dislocation will persist long after the immediate recovery period (25, 26, 77, 118, 175). Stress that emerges from disaster includes the loss of sense of place and social connection, livelihood, and, in some instances, dislocation from communities.

Rapid community change includes the recovery process after extreme events and disasters. Changes of this type have been observed more frequently with the increased exposure and vulnerability of populations and infrastructure owing to extensive development in flood zone sites on portions of the Atlantic and Gulf coasts that are prone to hurricanes and tropical storms. The character of recovery after disaster is embedded in place-based struggles, as documented by studies on disasters and neighborhood change (40, 119). Specifically, the capacity, condition, and direction of community change are altered in the aftermath of disaster itself (see 62, 166 as examples).

Studying disaster-driven abrupt community change is most fully articulated in case studies of flood events, where loss of life and property, injury, large-scale evacuation and potential dislocation, and critical infrastructure disruption take place (33). These kinds of sudden impacts change the quality of life for residents through inflicting disaster stress on communities. Significant work in this area has been done by sociologist Kai Erikson (62), who provided analysis of the psychological aftermath following a catastrophic dam failure, subsequent flooding, and almost total devastation of the town of Buffalo Creek in rural West Virginia. While the initial impact was significant, equally challenging was the lingering emotional toll and stress experienced by the survivors. The social networks, patterns of everyday life, and community identity were severely altered and impossible to regain.

The literature is also replete with well-documented examples of similar circumstances and outcomes resulting from large-scale hurricanes that affected the US coasts. Studies of Hurricane Hugo (in 1989), Hurricane Andrew (in 1992), Hurricane Katrina (in 2005), Hurricane Sandy (in 2012), and Hurricane Harvey (in 2017), among others, highlight the ways that disaster stress is experienced by communities. Hurricane Hugo affected the northeastern Caribbean and the southeastern United States, mostly impacting densely populated low-lying coastal communities. Studies looked at psychological distress from the event (86) and the kinds of stressors that correlated between financial capital and perception of loss (118). Hurricane Andrew greatly impacted the Miami area of Florida, causing large-scale disruption of social and financial resources (123, 166). During



Hurricane Hugo, communities that experienced greater exposure to hurricane damage through personal and property loss experienced greater stress (124).

The question of race and inequity, while evident throughout this research, is most profound in the context of the period following Hurricane Katrina as race-based struggles and housing market displacement brought significant community change to New Orleans and significant emotional stress to those who could not return to their homes or communities (25, 44, 70, 100, 121). Similar challenges were also presented by Hurricane Sandy in New York City, where concerns regarding inequity in postdisaster relocations, displacement, and community loss are still being felt (63, 88, 148, 153, 155).

### **Incremental Neighborhood Change and Stress**

Incremental community change occurs through socioeconomic shifts in coastal cities that happen slowly but have long-term impacts on communities. Communities change through various social mechanisms. These include a variety of political, economic, and social factors and manifest in a set of narratives, including economic development, turf politics, white flight, and gentrification (172). Incremental change can reach a tipping point where the nature and character of place could rapidly change from one type of community to another. This concept of tipping points in community change has been associated with conditions of demographic change in communities under many contexts. For example, the urban studies literature of the 1960s through the 1980s included case studies of how racial tipping points played a significant role in the shift from incremental to abrupt makeup of communities, where the ratio benchmark of one-third nonwhite was often presented as the tipping point measure (68). While this context seems removed from the conditions of community change in at-risk coastal communities, it is important to recognize the possibility of rapid demographic changes in such locales (1, 20).

Economic investment shifts have played a critical role in inducing residential displacement within cities. Specifically, urban geography studies have focused on how gentrification—the influx of more affluent residents and increases in commercial and residential property values in urban neighborhoods that have experienced years of disinvestment and economic decline—forces changes in racial and income community composition, availability of social and health services, employment opportunities, and housing availability and affordability (81, 74, 160). These changes are typically driven by market-oriented urban policies that include the privatization of public land, changes to homeownership rules, and land rezoning (122). The concept of gentrification has been applied to the climate adaptation context where policies and strategies result in changes in the real estate market—driving shifts in capital flow and development and dislocation of marginalized populations (51, 97).

Research has begun to focus on who is displaced across US urban communities to inform broader understandings of the geography of inequity and racism. The National Community Reinvestment Coalition (NCRC) studied the changing rate of socioeconomic status across census tracts of gentrifying US metropolitan areas from 2000 to 2010 and found that 110,935 black residents and 24,374 Hispanic residents were displaced (140). This cultural displacement of communities inflicts chronic stress on residents by increasing financial strain on families, forcing low-income residents to live in substandard housing owing to a loss of affordable housing, and reducing access to neighborhood resources such as employment, health services, and schools (12, 154).

The NCRC study also found that US coastal cities experienced the highest rates of gentrification (139). In the past five years, there has been an increase in case studies examining the process and impacts of gentrification and migration within US coastal cities (see, for example, **Supplemental Figure 3**). Gentrification of coastal cities has been found to amplify the impacts of current hazards that residents frequently experience from hurricanes and flooding by reducing



the ability of current residents to afford to stay in or return to communities that suffer extensive damage (17, 182). In particular, these inequities are amplified by coastal urban development plans that are focused on maximizing economic growth rather than community well-being (126). To substantiate these findings, studies typically use spatiotemporal data on socioeconomic status, land use and land cover change (LULC), and physical exposure to past and projected hazards to examine how economic changes affect the relationship between risk exposure, quality of life, and well-being for existing minority communities (1, 60, 127).

This analysis has been extended to studying climate change–related phenomena. The study by Keenan and colleagues (97) on climate gentrification in Miami-Dade County, Florida, illustrated a positive correlation between increasing prices of single-family homes in areas of higher elevation. This correlation was found to be an underlying causal driver of increasingly unaffordable properties and increasing displacement of residents from low-to-moderate-income communities. Several other works have noted this correlation as well, illustrating how low-income communities in less flood-vulnerable areas are being placed at risk owing to climate gentrification (51).

Studies have corroborated the climate gentrification thesis through direct observation in the postdisaster context, which includes the gentrification and dislocation of black communities following rebuilding efforts in New Orleans following Hurricane Katrina (17). Findings from studies on rebuilding efforts in New York City following Hurricane Sandy also demonstrated that postdisaster redevelopment efforts preclude the construction of lower-value homes for low- and moderate-income residents in at-risk, high-amenity sites. These projects typically favor resilient urban development projects for higher-income residents as has been observed in post-Hurricane Sandy New York City (59).

### **Risk Exposure, Place, Place Attachment, and Affinity**

Place, place attachment, and affinity have been extensively researched in a variety of social science and humanities disciplines and provide further insight on processes of risk exposure and behavior under conditions of stress (152). Urban geography and urban planning and related environmental psychological literature have contributed to the understanding of how individuals define place and their connection to it and, in turn, how their link to place can be attenuated or lost. Recent environmental psychology research has coined the term *solastalgia* to demonstrate how individuals can feel a sense of loss in relation to the places in which they live—even though they never relocated—owing to transformational change in their lived environments (9). This kind of distress has been attributed to environmental change that includes urban development, drought, mining, and SLR (8, 115, 117, 173). Through rich descriptions of individual experiences with environmental change, this research has emphasized the importance of understanding the factors that mediate individual behavior and an individual's connection to place (61, 71).

Places can be defined by a set of physical site and situational characteristics as well as perceived, culturally embedded functions and properties. Scannell & Gifford (152) define three key dimensions of place attachment. The personal dimension of place attachment refers to its individually or collectively determined meanings. The psychological dimension includes the affective, cognitive, and behavioral components of attachment. The place dimension emphasizes the place characteristics of attachment, including spatial level, specificity, and the prominence of social or physical elements.

In urban settings, a significant number of case studies have illustrated why, how, and when local residents decide to move in, move out, or remain in a neighborhood (as examples, see 7, 46, 156, 162, 163). Neighborhoods have place utility for residents in that they provide basic services and resources that enable the reproduction of everyday life. Close-knit neighborhoods have been described as towns within cities and are defined by multiple interpersonal interactions and

relationships (46). Neighborhoods by definition are always changing as one generation is replaced by the next, but other forms of change where significant directional demographic shifts take place are a more relevant analogy to coastal communities facing stresses of dynamic climate risk (112). Incremental unidirectional change, through investment, disinvestment, and demographic shifts, or situational changes, such as a reduction in access to the community via the construction of new infrastructure, bring an end to or lessen interactions while others may emerge (183). Income, age, employment status, and race/ethnicity are significantly associated with residents' decision-making strategies about whether to remain in or leave a community undergoing dynamic change (30).

While overall metrics of community quality of life are important for defining residents' perception of their neighborhood and desire to remain, residents will adjust their perceptions and attitudes to meet the conditions presented to them, often making adjustments to situations that outwardly seem to be undesirable or severely degraded (see 82). As a new pattern of change emerges, some households might be much more likely to relocate than other residents because the perceived drivers of change were highly significant for them or they were already considering relocation. At the other end of the spectrum, some residents might resist leaving under any circumstances and remain as a holdout. The crucial issue in these circumstances is when and why the pace of change dramatically increases.

### **Risk and Hazards in Communities and the Significance of Perception**

The perception of current and future risks and hazards and how they might shift the patterns of everyday life have significant impact on communities (105, 150). As noted in the new climate gentrification literature, risk perception can alter people's behavior or patterns of investment and economic practice in cities (see 51, 97). In the broader risk and hazards literature, authors have demonstrated that place attachment plays a critical role in shaping how residents perceive and respond to environmental risk, which potentially affects their acceptance of coping strategies (27, 48). Van Valkengoed & Steg (176) substantiated this theory through statistical modeling of motivational factors behind adaptation behaviors and found place attachment to be positively correlated with individual acceptance of adaptive behavior and to be a better predictor of individual uptake of adaptation strategies than individual knowledge of risk. These findings are broadened by Quinn et al. (137), who observe an optimism bias—where an individual believes a risk will not affect them—acting as a point of contention between place attachment and risk perception. While this belief encourages individuals to protect places that support their well-being, it also lowers their perception of risk even if measured risk in their community is high (136).

Studies of place attachment and risk perception in US coastal cities prominently show the tensions between emotional connection to place and responses to high levels of risk. These studies have focused specifically on managed retreat in the form of land acquisition or buyout programs following extreme flooding events. An assessment of the US Federal Emergency Management Agency (FEMA) floodplain buyout land acquisition programs showed that a resident's sense of place was a more accurate determinant of an individual's decision to participate in a buyout program than was increasing the resident's awareness of future flooding risk (65). Through analysis of flood data, and surveys and interviews with homeowners and city officials across various US coastal cities and floodplain sites in Louisiana, California, North Carolina, and Georgia, Kick et al. (98) found that the stronger the individual exhibited place attachment, the less likely they were to relocate.

The rationale behind these findings is substantiated by the Barile et al. case study comparison of rebuilt and relocated communities in New York City three years after Hurricane Sandy. The investigators found that individuals who rebuilt their homes in the same place exhibited less stress

and higher general health and well-being than did those who chose to participate in the buyout program in order to relocate (19). Vulnerability analyses performed on relocated communities in New York City showed that more than 20% of buyout participants moved to areas that were no less exposed to hazard than their original coastal community and that overall vulnerability increased by 26% for relocated residents (113). In many ways, these findings show that the perception of risk goes beyond the physical hazard itself for communities at risk of relocation, and instead feelings of place loss and threats to quality of life, access to resources, and social ties substantially impact residents' willingness to participate in coping strategies in response to the physical hazard (22, 50).

### **Risk and Hazard Response, Stress and Place Attachment**

Studies on the relationship between risk perception and place attachment demonstrate that communities are stressed not only by the impact of disasters and hazards but also by the response to these events and how the long-term recovery takes place. The recovery process is complex, as communities respond to coping decisions in different ways depending on their experience with hazards. For instance, in the postdisaster context of Hurricane Katrina in New Orleans, researchers found that risk perception is shaped by proximity to hazard and hazard experience, which meant that residents were less likely to engage with scientific evidence of flood risk that did not match their own experiences (79).

Risk communication and community engagement play an integral role in the effectiveness of risk and hazard response and can induce stress on communities in different ways if individuals feel alienated from the decision-making process (157). In a study of US Army Corps of Engineers involvement in land loss assessments in coastal Louisiana, affected communities were not as involved in the decision-making process as they expected to be. Residents felt that the land restrictions being imposed did not account for their values and their attachment to the landscape, accentuating their anxiety about rising sea levels and increased flood frequency (34). Furthermore, an individual's value of well-being and place attachment can take precedence over measured and experienced risk (2, 3). Socioeconomic variables such as length of occupancy, age, and owner or renter status affect the dynamics of community well-being and the response to risk reduction measures (81).

In many ways, risk communication likely needs to be tailored to a community's perceived risk and experiences rather than relying on universal scientific assessments (14, 35, 132). However, emotional attachments to place, while important determinants of how one perceives risk and experiences stress and anxiety, are seldom found in risk communication and policies in response to risk and hazards (143). Rollason et al. (145) suggest that a rethinking of risk communication is needed, focusing specifically on participatory approaches where local community members co-produce more effective types of local risk communication with experts and policy decision makers.

### **TRANSFORMATIVE ADAPTATION RESPONSES TO DYNAMIC URBAN COASTAL CLIMATE RISK**

Urban coastal communities in the United States have entered into vigorous policy debates on how to manage increasing risk of flooding. Many cities are engaged with coastal resiliency efforts that include the installation of gray (e.g., barrier walls and bulkheads to resist flood waters) or green infrastructure (e.g., wetlands to attenuate damaging wave action, beach sand dunes to block flood waters). However, within these incremental adaptation settings, the efforts work within status quo conditions and assumptions about occupancy and use of the shoreline. The increasing frequency with which coastal US cities are experiencing extreme weather events and the growing scale of populations impacted by climate-induced hazards have called into question the use of large-scale

managed retreat to cope with environmental change (161). If an adaptation response includes managed retreat, it is a kind of collective decision that is based on levels of risk that are deemed to be especially problematic (120). As such, large-scale managed retreat is a form of transformative adaptation.<sup>3</sup> Residents' reaction to managed retreat policy interventions can inflict stress and anxiety as their responses are deeply reflective of place attachment and risk perception. This situation played out in New York City's borough of Staten Island following Hurricane Sandy in 2012 when the State of New York initiated a substantial buyout program in the flood-inundated areas. Almost immediately residents organized for and against the program, resulting in increased community tension in the post-extreme event recovery period (see **Supplemental Figure 4a,b**).

With the exception of a few studies that focused on specific community experiences, analyses that tried to understand the implications of managed retreat as a form of climate adaptation were crafted as projections (e.g., 10) and opinion pieces (e.g., 6). These pieces have tried to expand place attachment and environmental risk literature into the context of climate-induced migration and displacement and community well-being. Agyeman and others (6) hypothesize that climate change will compound the effects that communities will feel from already-existing anxiety, grief, and loss due to current uneven socioeconomic disparities and increasing displacement from places. The authors project that without significant attention to the psychological needs of coastal residents—especially those in at-risk populations—there will be negative emotional and symbolic outcomes, which will compound the more conventionally highlighted economic effects (6).

In reframing managed retreat as climate adaptation, Hino et al. (90) conducted a comprehensive meta-analysis of 27 managed retreat cases as examples of transformative adaptation across a variety of environmental contexts to capture the added complexity of the large-scale impacts of climate-induced displacement. The authors present a framework that links residents' positive or negative attitudes on relocation to whether residents initiated the move and who benefits—the broader society or only residents that relocated. Embedded within these variables are questions of trust, governance effectiveness, distributional risk and benefits, and risk perception. In the analysis, attempts at transformational adaptation will bring heightened stress and anxiety to communities unless efforts are managed from the outset in a way that includes social justice issues, incorporating resident concerns, values, socioeconomic development context, and aspirations. A subsequent review of the social justice implications of large-scale managed retreat in urban coastal or riverine settings identifies the potential increase in disparities among low-income and minority residents by exacerbating social and racial inequalities (109, 161). Siders (161) and Alexander et al. (10) found a range of similar psychological factors associated with scenarios of managed retreat, including the fear of the unknown, optimism bias, place attachment, and the notion that retreat is equivalent to defeat.

Implementation of large-scale managed retreat is further complicated because of its connection to place attachment and acceptance of adaptation strategies (47, 89). Amundsen's (11) study of two northern Norway towns, for example, defines how the subjective quality of place attachment positively influences support for adaptation efforts (11). Yet other case study analyses specify that transformative adaptation can negatively affect place attachment and increase local resistance to such efforts (35, 103). Through a survey of coastal residents in County Dublin, Clarke et al. (38) analyze the connection between place attachment and proposed transformative flood defenses.

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<sup>3</sup> Such adaptation is associated with more profound shifts than resiliency efforts to deal with unacceptable levels of risk and occurs where a new system of risk management emerges through a paradigm shift in policy or practice that alters the everyday life of the community (45; see Reference 117 and the IPCC AR5 for a full definition of incremental versus transformative adaptation).

The results suggest that where transformative adaptation disrupts place and threatens place attachment, it must consider the views of both those affected and those unaffected by hazardous events. Three summary statements illustrate the challenge that ongoing transformative adaptation will have: (a) Transformation is likely to be resisted by individuals if it inversely disrupts place, (b) strength of place attachment is inversely correlated with perceptions of fair governance, and (c) flood risk or experience does not impact the strength of place attachment or support for adaptation.

Overall, research on the connection between place attachment and adaptation impacts and success is rapidly growing, and several significant research areas are emerging. For example, the interplay between institutional practices and responsibility and residents' adaptive practices has significant influence on how adaptation responses affect communities (138). Property rights, access to resources, risk perception, social capital, institutionalized racism, and income inequalities are important mediating factors in the uneven distributional impacts of adaptation plans (58, 75). Another emerging research area is residential displacement via adaptation responses, which can drive competition for limited resources in urban environments where a limited amount of land is available and costs for resettlement land are high (14, 97).

## CONCLUDING THOUGHTS

This review of climate and environmental stressors, community change, and well-being within the urban coastal context shows the socioeconomic conditions that need to be considered within risk reduction strategies generally and transformative adaptation strategies such as managed retreat specifically. Changes in climate and the urban environment inflict dynamic stressors on urban coastal communities. Through comparing general climate change literature alongside risk and hazards literature on urbanization, community change, and place relationships, this review has shown that contrasting abrupt and incremental changes affect urban coastal communities. Climate change stressors can be abrupt such as extreme weather events, or they can be incremental through slow-onset hazards such as SLR. However, this research on community change was limited and did not take into account the broader social inequities that affect where and how urban coastal communities feel more significant and longer-lasting environmental changes.

This knowledge gap is significant, as coastal cities are going through rapid and transformational changes that are dynamically affecting residential exposure to social, ecological, and technological hazards. The social science literature helps fill in this gap by focusing on how economic changes such as gentrification affect the relationship between risk exposure, quality of life, and well-being for existing communities. This literature was covered by various fields in risk and hazards, environmental psychology, and urban geography and found that economic changes amplify chronic stressors that communities experience by changing the character of neighborhoods, which breaks social ties and interrupts how communities relate to people and the places in which they live. Studies of the manifestation of these chronic stressors show that place attachment and risk perception establish conditions for community well-being and influence households' decisions to relocate and their responses to broader risk reduction policies and plans.

In many ways, policy and planning responses to hazards can worsen quality of life for residents if these socioeconomic contexts are not considered. For instance, managed retreat has been a well-documented response to flood risk and hurricane destruction in urban coastal communities where relocation can compound the anxiety and stress that individuals feel following a disaster. And as hurricanes increase in frequency and intensity and SLR-related flooding occurs more often, US coastal cities are considering larger-scale forms of managed retreat as a way to adapt to flooding. This review has demonstrated that large-scale forms of managed retreat are being considered as

transformational adaptation responses, but thus far they have been documented as resulting in trade-offs with community quality of life. Often, in these contexts, uneven distributional effects of retreat actions and policies affect living conditions, access to employment, and sense of place for a majority of low-income and minority residents. Urban studies research has noted that these trade-offs create contentions between communities and policy makers (13, 59, 80). These issues will increase in the future as projected climate change and associated SLR lead to more frequent extreme flooding events and mean monthly high tide flooding in low-elevation sites. In the case of New York City, future SLR will put large swaths of the land area under conditions of increased risk, accelerating the potential for transformative adaptation (see **Supplemental Figure 5**).

Concerns remain if large-scale managed retreat as a form of transformational adaptation continues trends from current market-driven urban coastal policies that prioritize economic growth over community well-being. In some ways, this solution is perpetuating past issues of risk and hazard reduction programs, which promoted generalized ideas of risk based on measurable and quantitative approaches and minimally considered tailoring responses to community place-based values and experiences. Moving forward, research on risk communication and community engagement are potential avenues to ameliorate some of these issues and improve quality of life for urban coastal communities. This growing field of research has shown that community framings of social and environmental change are connected to residents' daily experiences, which influence issues that they see should take priority within transformative adaptation planning. From the community point of view, transformative adaptation generally results in the loss of meaningful places, and hence large-scale managed retreat might promote a different kind of reality than what communities are experiencing. In this way, involving communities throughout the adaptation process can help create policies and plans that consider their values and maintain and improve quality of life.

## DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

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