



# Climate Gentrification: Methods, Gaps, and Framework for Future Research

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The topic of climate gentrification has been receiving increasing attention in both peer-reviewed literature and in popular discourse. Climate gentrification refers to the ways that climate impacts and adaptations may contribute to changes in community characteristics and potential displacement of vulnerable residents through changes in property values. Here, we conduct a review of the current literature on climate gentrification in order to understand methods and key themes, identify research gaps, and guide future research. Our search yielded a total of 12 relevant articles, beginning in 2018. After reviewing these articles, we identified several key methodological gaps including the lack of participatory methods, limited availability of longitudinal data, difficulty defining and measuring displacement, and challenges surrounding causality. We suggest that future work on climate gentrification should draw from Coupled Human and Natural Systems (CHANS) theory to further understand the complex feedbacks that exist in climate gentrification dynamics. To guide future research, we propose a framework as a CHAN that highlights the multi-spatial, multi-temporal, and multi-faceted dimensions of climate gentrification.

**Keywords:** climate change, gentrification, adaptation, housing, vulnerability

## INTRODUCTION

It is well-established that the impacts of climate change are poised to disproportionately impact groups of people that have less adaptive capacity and have contributed the least to the problem, and this is also true within cities (Schlosberg and Collins, 2014; Anguelovski et al., 2019; Rice et al., 2020). Similarly, climate change adaptation action at the local level, much like climate impacts, has the potential to reinforce uneven risk exposure and socio-economic vulnerability across groups within a community (Caulfield, 1994; Smith, 2005; Dooling, 2009; Quastel, 2009; Pearsall and Anguelovski, 2016).

Researchers and the media have started to popularize a theory of “climate gentrification” as a mechanism by which climate change may contribute to inequality in housing. Though there are varying definitions, climate gentrification is the idea that climate impacts and adaptations may contribute to differences in property value (Flavelle, 2016; Bolstad, 2018; Keenan et al., 2018). In this way, climate change may interact with gentrification by creating and reinforcing pathways of displacement due to economic, physical, and social upgrading (Slater, 2006; Lees et al., 2013). It has been suggested that climate gentrification is already occurring in several cities in the U.S. (Flavelle, 2016; Milman, 2018; Zanzilotti, 2018; Benson, 2019).

As with any new area of research, there is much work to be done to understand the complexities of climate gentrification. With the peer-reviewed literature and popular discourse on climate gentrification growing, it is important to consider the current state, gaps, and future directions of research in this area. The goal of this article is to begin to assess the emerging field of climate gentrification and guide future research. Here, we present a review of the existing peer-reviewed literature, which allows us to synthesize the state of the literature and present a framework of climate gentrification that can unify current work and inform future research.

## METHODS: LITERATURE SEARCH

To conduct this review, we searched Web of Science using the keywords “climate” + “gentrification”. Results were limited to only English-language articles. This initial search yielded 69 total articles. These articles’ abstracts were manually screened based on the following criteria:

1. Only articles with a study area in the United States
2. No review articles
3. Peer-reviewed

Finally, full-text articles were further screened manually based on relevance to our climate gentrification topic. While an article did not have to explicitly mention “climate gentrification” to be included, it did have to refer to gentrification in the context of a climate related impact or adaptation. After our review and screening, we identified a total of 12 relevant articles for full evaluation (Table 1). During the evaluation of these articles, we extracted information related to climate gentrification definitions and mechanisms, data and methods, and identified gaps or future work.

## RESULTS

### Definitions and Mechanisms of Climate Gentrification

Beginning with Keenan et al.’s pioneering work in 2018, we identified 12 relevant articles at the time this review was conducted (Table 1). Keenan et al.’s work establishes the groundwork for the study of climate gentrification. It provides a model for “the pathways by which climate change could operate to impact geographies and property markets whose inferior or superior qualities for supporting the built environment are subject to a descriptive theory known as ‘Climate Gentrification’” (Keenan et al., 2018). They propose three possible pathways for climate gentrification: superior investment, resilience investment, and cost-burden (Keenan et al., 2018). With our review, we identify typologies of climate gentrification and how they connect to Keenan’s three pathways, demonstrating how these definitions are connected within the literature (Figure 1). This allows us to highlight how the field has been evolving.

All of the papers that explicitly refer to climate gentrification include citations to Keenan et al. (2018), highlighting its

importance in the field (McAlpine and Porter, 2018; Aune et al., 2020; de Koning and Filatova, 2020; Shokry et al., 2020). McAlpine and Porter’s work draws from Keenan’s definition of climate gentrification to study real-estate financial losses and projected losses due to flooding (2018). Their work provides additional evidence for Keenan’s described superior investment pathway of climate gentrification phenomenon of climate exposure translating into changes to property values (McAlpine and Porter, 2018). Similarly, de Koning and Filatova reference Keenan et al. (2018) but further emphasize traditional gentrification outcomes including displacement of low-income residents due to superior investment (de Koning and Filatova, 2020). Aune et al. also place additional conceptual emphasis on socioeconomic factors of climate gentrification including shifts in community racial composition, education, and income level, though their overall definition of climate gentrification draws directly from Keenan et al. (2018) and Aune et al. (2020). Shokry et al. (2020) propose “green resilience gentrification” as an additional pathway to climate gentrification in which the selection of sites for green resilience infrastructure projects work to reinforce social and environmental vulnerability.

The remaining articles, which do not explicitly refer to “climate gentrification”, still meet the criteria of our review in that they all explore gentrification in the context of climate-related impacts or adaptation measures. We include these seven works because they can help us understand climate gentrification more broadly than the current, narrow literature. The majority of these papers fall broadly into the category of the “resilience investment” pathway of climate gentrification, in which resilience investments into a community can lead to increases in property values and gentrification outcomes (Turan, 2018; Finewood et al., 2019; DiValli and Perkins, 2020; Shokry et al., 2020). This is especially true when community members are not actively included in the process (Turan, 2018; Finewood et al., 2019).

These works are aligned with Shokry’s pathway of climate gentrification through green resilience infrastructure (Shokry et al., 2020), which we consider as a subset of Keenan et al.’s resilience investment pathway (2018). Turan (2018) applies critical urban theory to the case of rezoning and revitalization in Gowanus, NY and describes how rezoning, motivated by addressing flood risk, leads to socio-political exclusion and gentrification due to lack of community participation. Similarly, Finewood et al. (2019) argue that investments into green infrastructure for stormwater management can lead to culture loss and gentrification. Shokry et al. (2020) makes a similar argument against “green resilience gentrification” in which green resilience infrastructure may contribute to new landscapes of environmental injustice. Distinctive from gentrification and displacement driven by resilience investments, DiValli and Perkins (2020) argue that resilience planning may achieve resilience through the displacement of residents, where displacement is not a side-effect of resilience planning but a direct aspect of it.

Another important distinction that emerges in the literature is post-disaster gentrification. DuPuis and Greenberg (2019) explore how resilience investment after Hurricane Sandy risks leaving out the most vulnerable residents in New York City. In

**TABLE 1** | Summary of research articles in the review including primary definition of gentrification, methods, data, and key themes.

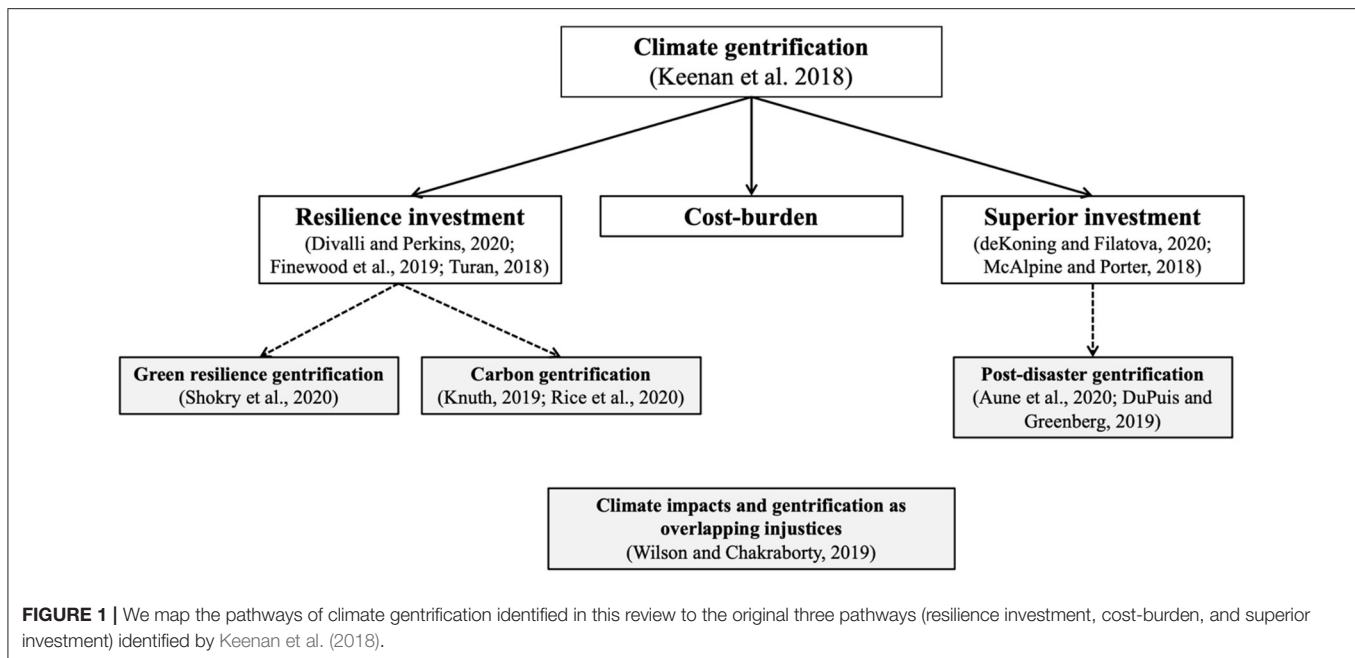
References	Definition and mechanism of gentrification	Methods	Environmental indicators	Social indicators	Housing indicators	Other indicators	Themes
Keenan et al., 2018	<b>Climate gentrification:</b> Pathways by which climate change impacts geographies and property markets (includes superior investment, cost burden, and resilience investment)	Quantitative and Qualitative: Semi structured interviews and then regression	Elevation	None	Property values	None	climate gentrification; Miami-Dade; superior investment; cost burden; resilience investment; elevation
McAlpine and Porter, 2018	<b>Climate gentrification:</b> redistribution of population and investment into areas lower risk to flooding	Quantitative: Existing data and models/projections	Sea level, tidal gauge data, elevation, storm surge	None	Proportion of property flooded, estimated loss of property value	None	property values; tidal flooding; Miami-Dade; projections; financial loss
Turan, 2018	<b>Rezoning/revitalization</b> under the guise of responding to climate change cultivates socio-political exclusion and gentrification	Qualitative: Critical urban theory, community observation	Flood risk and past contamination	Income, race	Census level home sale values and rent	Rezoning - Loss of jobs, affordable retail	right to the city; local green voice; environmental justice; participation; rezoning; revitalization;
Knuth, 2019	<b>Retrofitting and energy efficiency</b> contribute to increases in property values and gentrification	Qualitative: historical	Energy efficiency	None	None	None	retrofitting; green growth; decarbonization; green tech interests; political ecology
DuPuis and Greenberg, 2019	<b>Resilience investment:</b> resilience infrastructure leaves the most vulnerable out. Asks: who has the right to a resilient city?	Qualitative: Document analysis	Post-Sandy development project to reduce future storm surges	None	None	Community engagement	post disaster recovery; green growth machine; equitable resilience; right to resilient city; Sandy
Finewood et al., 2019	<b>Green gentrification:</b> reference gentrification including culture loss due to green technology/infrastructure	Qualitative: interviews	Green stormwater infrastructure	None	None	None	values of community; democratic participation; infrastructure; stormwater; urban political ecology
Wilson and Chakraborty, 2019	<b>Gentrification is a contributing factor,</b> not a driver, to changes in spatial distribution of vulnerability to extreme heat over time	Quantitative: Vulnerability index and mapping with census data	Land surface temperatures	Age, education, poverty, race, income, access to car	Proportion of renter households, mobile homes, group quarters	Access to air conditioning	extreme heat; vulnerability; adaptive capacity; spatial distribution of risk
de Koning and Filatova, 2020	<b>Climate gentrification:</b> Speculative investment in lower risk areas, pushes high-income households to safer areas while drawing lower-income households to riskier areas	Quantitative: spatial agent-based model, secondary data and interviews to calibrate/develop heuristics	Flooding	Household income, housing budget	Residential property	Agent decision heuristics, risk perception	Agent-based modeling; buyers and sellers; market-driven; trapped populations; environmental injustice; superior investment; poverty

(Continued)

TABLE 1 | Continued

References	Definition and mechanism of gentrification	Methods	Environmental indicators	Social indicators	Housing indicators	Other indicators	Themes
Rice et al., 2020	<b>Carbon gentrification/ecological gentrification in a “climate friendly” city:</b> low-carbon urban development as a driver of gentrification	Qualitative: interviews, observation, also some document analysis	Climate mitigation efforts through urban design	Change in racial composition, education, income	Change in the median home value and average median rent	None	low-carbon development; urban design; segregation; housing justice; just green enough; climate justice
Shokry et al., 2020	<b>Climate gentrification/Green resilience gentrification:</b> Resilience investment, green resilience infrastructure leads to gentrification outcomes	Quantitative: spatial analysis and scoring with secondary data	Combined Sewer System (CSS) area, FEMA 100-year floodplain and impervious surfaces	Poverty, education, unemployment, race, age, limited English language proficiency	None	Gentrified census tracts	public-private investment; green resilience infrastructure; new landscapes of environmental injustice; maladaptation; segregation
Aune et al., 2020	<b>Climate gentrification:</b> effects of climate change alter housing values in a way that leads to gentrification	Quantitative: Threshold and gentrification index with secondary/ACS data	Elevation, median flood depth	Race, ethnicity, education level, economic characteristics	Renters, dwelling type, housing density, new construction, resident relocation	None	pre and post storm; elevation; income; inequality; gentrification; Katrina
DiValli and Perkins, 2020	<b>Resilience through displacement:</b> Community resilience obtained through displacement of residents, adding to risk of social upheaval and housing insecurity	Qualitative: Document analysis, interviews	Perceived rainfall flooding, extreme heat, climate change	Perceived economic inequality, educational opportunity gap	Perceived lack of affordable housing	Public transportation access, sense of place	Urban development; neoliberal growth model; displacement; urban riskscape; resilience planning; inequality; social capital; right to return

Articles are listed in chronological order of publication date.



a similar vein, Aune et al. (2020) choose the context of post-Katrina New Orleans to begin to assess temporal dimensions of climate gentrification. In these works, it seems possible that natural disasters may serve to speed up the gentrification process by creating new opportunities for investment and urgency for resilience infrastructure. Therefore, post-disaster gentrification may operate through a combination of Keenan et al.'s (2018) superior investment and resilience investment pathways.

This review also identifies an additional pathway of climate gentrification in the ways that energy efficiency, retrofitting, and low-carbon urban development can contribute to gentrification outcomes by increasing property values (Knuth, 2019; Rice et al., 2020). These pathways, which Rice et al. (2020) calls “carbon gentrification” are an important contribution to the understanding of climate gentrification as carbon mitigation efforts increase and, we propose, may be considered a unique subset of climate gentrification *via* resilience investment.

Finally, one article included does not directly link gentrification outcomes to climate impacts or resilience efforts, but rather suggests that gentrification could be an underlying process that contributes to unequal distributions of climate impacts (Wilson and Chakraborty, 2019). This work is a reminder that processes of climate change and gentrification interact in complex ways to contribute to climate justice or injustice. The emerging field of climate gentrification should consider not just where climate change or climate resilience drive gentrification, but all the different ways that gentrification and climate change may be interlinked and contribute to social and climate injustice.

## Methods and Data

Works in this review employ a range of methods and data (Table 1). Six of the papers use quantitative methods including

regressions (Keenan et al., 2018; McAlpine and Porter, 2018), the development of indices (Wilson and Chakraborty, 2019; Aune et al., 2020), spatial analysis (McAlpine and Porter, 2018; Wilson and Chakraborty, 2019; Shokry et al., 2020), and agent-based modeling (de Koning and Filatova, 2020). The remaining six articles utilized qualitative methods including document analysis (DuPuis and Greenberg, 2019), interviews (Finewood et al., 2019), community observations (Turan, 2018), historical analysis (Knuth, 2019), or these methods in combination (DiValli and Perkins, 2020; Rice et al., 2020).

We are also interested in the data and indicators that these works utilize. To assess this, we looked at each article and identified what, if any, environmental, social, and housing indicators were used (Table 1). From this, we see that environmental or climate considerations most frequently include flooding in some form, whether that is elevation as a proxy for flood risk (Keenan et al., 2018) or future projections of flood risk due to sea level rise (McAlpine and Porter, 2018). Several of the articles also include consideration of extreme heat with direct land surface temperature data (Wilson and Chakraborty, 2019) or data regarding community perceptions of heat (DiValli and Perkins, 2020). Other articles use data about resilience infrastructure or green investments as environmental indicators (DuPuis and Greenberg, 2019; Rice et al., 2020).

A wide range of social indicators were used across the articles reviewed. Five of the articles do not include any consideration of social or economic variables (Table 1). When socioeconomic indicators are included, race and income are the most frequently used. Some works also include age, education (Wilson and Chakraborty, 2019), English language proficiency, and unemployment (Shokry et al., 2020). As with the social indicators, the use of housing indicators varies widely in this work, and four of the articles do not consider housing or

property indicators explicitly (Table 1). The most common housing indicator used is property values (Keenan et al., 2018), while one article also considers community housing characteristics including housing density, new constructions, and rates of resident relocation (Aune et al., 2020). Beyond specific environmental, social, and housing indicators, other indicators include rezoning data (Turan, 2018), community engagement (DuPuis and Greenberg, 2019), access to air conditioning (Wilson and Chakraborty, 2019), and sense of place (DiValli and Perkins, 2020).

## Key Themes

From the identification of key themes in each paper (Table 1), the concept of the neoliberal growth model, in which economic development and private interests are valued above all else, is used to describe much of the broad processes that lead to gentrification in general. As DiValli and Perkins (2020) state, the neoliberal growth model of development often results in the displacement of poor residents (often of color) and their replacement with middle-class white residents. As an extension of the neoliberal growth model, other articles emphasize the emergence of a “green growth machine” (DuPuis and Greenberg, 2019; Knuth, 2019) in which urban greening efforts are employed to increase property values, while poor residents carry the greatest social and environmental burdens but receive less of the benefit (DuPuis and Greenberg, 2019). In this way, this analysis of key themes highlights how overarching economic incentives and systems interact with resilience planning to contribute to exclusion, of which climate gentrification is one possible outcome.

As climate gentrification stems, in part, from exclusion of vulnerable groups, community engagement and the democratization of urban climate resilience planning are important additional themes that are identified. Beyond climate change exposure and risks, the literature highlights that climate mitigation and adaptation actions can be a strong contributor to gentrification, especially where local community participation is not included. Without the “local green voice” (Turan, 2018), or the inclusion of locals in resilience planning, infrastructure and investment can further result in the socio-political exclusion and eventual displacement of community members.

Finally, the themes of the right to the city and justice are prevalent in these works. Questions of who has a right to a city (especially the right to a resilient city) underlie questions of climate gentrification (DuPuis and Greenberg, 2019). Climate gentrification raises questions related to “Who has the right to a safe environment?” and “Who has the right to climate protections?” Such questions have profound implications for climate justice as both the impacts of climate change and the benefits of climate resilience measures are unequally distributed. These questions should underlie future research and policies surrounding climate gentrification and just climate adaptation. Taken together, these key themes and guiding questions highlight the spatial dimensions of climate gentrification from macroeconomic systems to the local community participation.

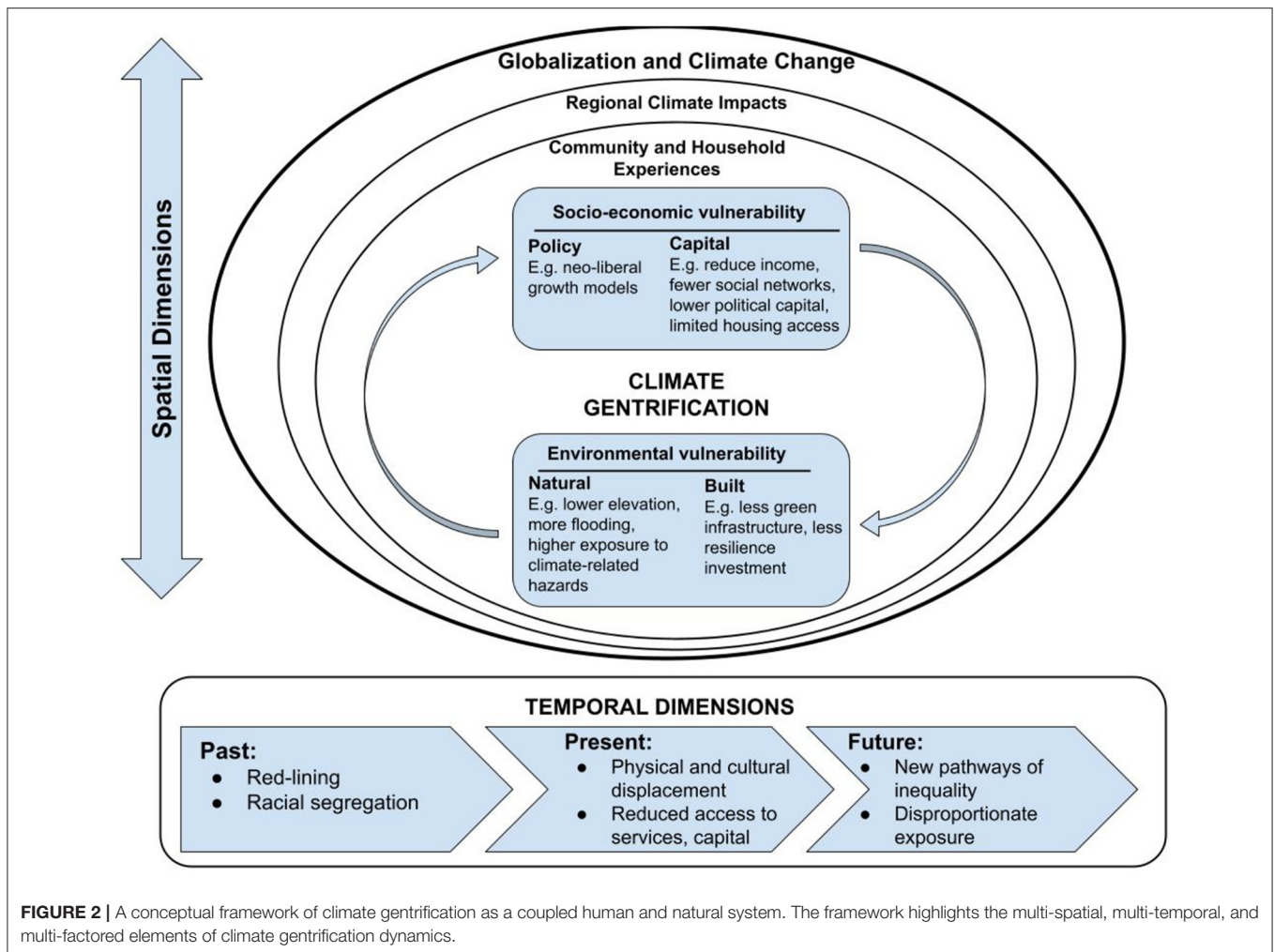
## DISCUSSION AND CONCEPTUAL FRAMEWORK

From Figure 1, we immediately see that Keenan et al.’s cost-burden pathway of climate gentrification is understudied (Keenan et al., 2018). This pathway describes the idea that lower income households may be forced to relocate from high climate exposure areas due to the inability to afford the costs of remaining in place (such as insurance premiums, repair costs, etc.). None of the papers in this review could be classified under the cost-burden pathway, while the majority of the papers identified can be classified under the resilience investment pathway (Figure 1). Future studies that aim to consider cost-burden pathways of climate gentrification may need to incorporate new sources of data and indicators such as socioeconomic characteristics over time, insurance data, and climate damages.

By analyzing methods and key themes, we found that lack of participatory methods, longitudinal studies, and consideration of displacement to be a few key gaps in the climate gentrification literature. As has been discussed, where local residents have no voice in local governance, they cannot effectively advocate for their benefits, and consequently their needs can be overlooked. As an extension, research on climate gentrification should utilize participatory methods to ensure that the local voice is included. One possible example of getting engaged with the residents might be participatory mapping of residents’ cultural values in a way that emphasizes knowledge co-production (Norström et al., 2020). Cultural values are important components and indicators of gentrification but might not be apparent to an outsider. For example, the places that people have the strongest sense of place or are meaningful for the community can be identified by them and researchers can bring them to the maps and make the invisible cultural assets of the community visible. By making the invisible, visible, local advocates may be empowered and policy makers and planners can include these data into their plans.

Considering temporal scale, most studies either happened during a specific time (e.g., after a hurricane) or they took place in a short span of time. We suggest that longitudinal studies can be helpful to have a better understanding of the sequence of processes and can provide in-depth understanding of the issue. For example, longitudinal studies will help us to identify the possible pre-stages of gentrification and enable policy intervention. In addition, some important social concepts related to gentrification, such as poverty, are dynamic. Furthermore, climate gentrification is likely related to historic events such as red lining and racial segregation in the past that led to the current uneven distribution of higher exposure to climate risks and lower access to green infrastructure. Hence, we suggest that climate gentrification studies need to take a temporal perspective.

Displacement is one of the most important components of gentrification, but a nuanced consideration of displacement and its different forms is lacking in the climate gentrification literature. Direct displacement (due to the high prices residents can’t afford to stay in neighborhood), indirect displacement/exclusionary displacement (the high prices are barrier to low income to get into the neighborhood), and finally cultural displacement (with transformation of neighborhood and



services provided, the remaining older residents feel detached from the neighborhood), are examples of displacement due to gentrification (The Uproot project<sup>1</sup>) More in-depth studies with differentiation of various types of displacement are suggested for future research. To address these gaps and future challenges related to climate gentrification research, a combination of top-down methods and data (quantitative), such as remote sensing data for earth observation as well as the bottom-up methods (qualitative) such as interview and photo elicitation should be utilized.

Ultimately, this review highlights the complexity of climate gentrification as a multi-causal, multi-spatial process that involves dimensions of both natural and human systems. As climate gentrification considers both natural (climate change) and human (housing, displacement, justice, etc.) systems, we propose that it can be studied, and some of the identified gaps in the current literature may be addressed most effectively, by utilizing Coupled Human and Natural Systems (CHANS) theory (Ferraro et al., 2019). After reviewing the existing literature, we have developed a framework to help explain the

complex temporal and spatial dynamics of climate gentrification as a CHAN (Figure 2). According to the framework, climate gentrification happens across global and regional scales spatially and from the past to future temporally. Consistent with our analysis of data sources and methods, we divided the main components of climate gentrification into two main categories of socio-economic and environmental variables. In this framework, all components are interconnected and any change in one group of variables can be a driver of change for the other group. For example, political exclusion and lower social capital, can lead the minorities to live in congested neighborhoods with very limited green infrastructure. This will increase the community's vulnerability through increasing the exposure to climate change hazards (e.g., flooding) and will exacerbate their situation.

Our hope is that this framework will help to inform climate gentrification research as it expands. Future research must embrace and acknowledge the complexity of climate gentrification as a CHAN in order to advance research as well as provide insights for policymakers and communities. The emerging topic of climate gentrification highlights the need to consider multiple human and natural dimensions in future climate adaptation policy. To address possible future climate gentrification, such multi-faceted policies are needed to avoid disproportionate impacts on low-income and vulnerable

<sup>1</sup> Available online at: <https://sites.utexas.edu/gentrificationproject/understanding-gentrification-and-displacement/>.

populations (Anguelovski et al., 2019; Thomas and Warner, 2019; Shokry et al., 2020).

## AUTHOR CONTRIBUTIONS

All authors contributed equally to the conceptualization, development, and writing of this work.

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