Advancing a hyperlocal approach to community engagement in climate adaptation: Results from a South Florida pilot study in two communities

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Abstract

With increasing urgency of local and regional climate adaptation, there is a growing need for governments to identify and respond effectively to the concerns of communities they serve and to align investments. We designed and piloted a novel hyperlocal method for urban adaptation planning combining two social science tools that have been widely but separately used to foster community engagement and strategize solutions. Our not-for-profit community partners facilitated multi-session online workshops with participants from two communities in South Florida with whom they have well-established relationships and in which socioeconomic conditions and climate risks represent notable vulnerabilities. The workshops first employed photovoice to elicit individual narratives about climate change impacts; participants then followed a design thinking protocol to critically evaluate the leading concerns they identified and propose adaptation solutions. Geospatial mapping and data tools were provided for participants to gain additional tools and further knowledge. Local planning and resilience officials attended some or all of the workshops as observers and interlocutors, dialoguing with participants. Comparative analysis revealed differences in risk awareness and primary concerns between communities, and further demonstrated that concerns and solutions proposed by members of at-risk neighborhoods do not always align with geospatial data that often drives infrastructure adaptation planning in the region, suggesting that more widespread use of community engaged methods could enhance government climate adaptation responses for local communities.
Introduction

The effects of climate change pose threats to communities worldwide with many urban coastal communities facing multiple impacts from sea level rise, more frequent and intense storms, and heat events [1, 2]. As awareness of this existential threat grows among governments, community organizations, and community members, there is a pressing need to develop and test new adaptation strategies "that integrate stakeholders in the design and implementation responses (p. 1)" and account for sociocultural as well as geographical and climatic conditions [3]. A recent comprehensive assessment of global adaptation plans identified priorities for adaptation research, among them the development of strategies that “enable individuals and civil society to adapt,” which might entail collective action for social change [4]. Given that current strategies focused on preserving capital and property can leave large numbers of community members behind [5], interventions that draw upon the social and human capital of neighborhoods to identify vulnerabilities at a hyperlocal scale, and align decision making with locally relevant concerns and threats, might yield better outcomes [6–12], as there is increasing recognition that climate resiliency should revolve around the intersections of public policy and actions by individuals and households as well [13]. While calls for more participative processes are ongoing, methods and approaches to improve engagement are still under researched [14, 15]. Echoing the research, our team, having observed more than a decade of regional, county, and municipal responses to threats from climate change in South Florida, recognized the limitations of responses that emphasize infrastructure to the near exclusion of social resilience, rely primarily on outside consultants who elicit minimal input from community members, and fail to lay the groundwork for long-term engagement by residents of affected neighborhoods [see, for example 16–18].

With the goal of advancing research and practice related to community-engaged research and hyperlocal climate adaptation, this paper (1) details how our approach to community engaged research builds on two existing processes of photovoice and design thinking, (2) describes our alternative, a synthesis approach that we conducted in online workshops with two Miami-Dade County neighborhoods (Homestead and Little River) in July 2020, during the early months of the Covid-19 pandemic, and (3) summarizes outcomes, including comparative analysis between the communities, the alignment and variations in the issues raised by community members in relation to vulnerabilities identified by geospatial data, and possible impacts of the HyLo process on individual and community capacity. Key representatives from local government planning offices participated in all of the workshops, with additional representatives joining during a final exhibition and discussion by participants that focused on how to move projects forward using existing resources. Comparisons between the two neighborhoods to examine variations in local perceptions of risk and desired solutions are key to our findings about the importance of focusing on hyperlocal adaptation. In addition to key findings, we discuss lessons learned about community engagement around climate adaptation in the pandemic environment.

The hyperlocalism method

Focusing on local engagement and action, we developed and piloted the Hyperlocalism approach—hereafter ‘HyLo’—a community-driven method for climate-adaptation planning [19]. The HyLo method builds on partnerships among local community organizations, residents, and representatives from local government departments to address existing and future challenges at the neighborhood level and create a more equitable future for communities facing enhanced social and geographic climate risks. The HyLo method utilizes a communication as design (CAD) approach [20, 21] to redesign two widely used community-based protocols of...
inquiry and deliberation, photovoice and design-thinking. CAD approaches [19–21] seek to change communication processes from “what is” to “what is desired” by examining communication structures for their normative goals, redesigning protocols and interactions to help achieve those goals, and addressing unexpected outcomes and limitations of the communication protocols. We further developed an Integrated Climate Risk Assessment (ICRA) tool that would enable users to consider multiple aspects of risk. This effort responds to a growing recognition that climate risks intersect across multiple physical threats (heat, flooding, drought . . . etc.), as well as social, economic, and ecological vulnerabilities [22]. Overall, our approach combines education and geospatial mapping of risk with our integrated approach to community-based participatory action to provide a framework for residents to share their lived experiences, advance collective knowledge about neighborhood assets and vulnerabilities, imagine possible solutions, and communicate their priorities with government leaders. We designed the HyLo method with scalability and replicability in mind. Central to our approach is the aim of enabling community organizations in diverse circumstances and locations to replicate the HyLo method.

Below we review photovoice and design thinking, identifying key strengths, limitations, and gaps to each process.

**Photovoice: Goals, current research, and gaps.** Photovoice is a process whereby community members take photographs and tell stories about their communities, engage in dialogue, and present their work through exhibition to policymakers [23]. We view photovoice as the enactment of hyperlocal identification of risk, vulnerability, and potential for action. Photographs and stories from participants focus on their direct experience in their communities and represent concerns for the locations that impact their daily lives. As such, photovoice is a central component of our novel community-based participatory approach to stakeholder engagement and climate adaptation planning.

A distinct extension of photo novella [24] that was formally introduced by Wang and Burris in 1997 [24], this qualitative method of inquiry empowers individuals to capture experiences in their communities, promote dialogue that produces collective knowledge, and communicate with policymakers and other stakeholders in positions of power [25]. Due to its flexibility and adaptability, photovoice is particularly well suited for community-based participatory research [23, 26]. Over the last two decades, photovoice has grown in popularity [26, 27] and been used in contexts from physical and mental health [27, 28] to community development [29] and been shown to be accessible to people in a range of age groups and other demographics [30, 31]. Photovoice can be delivered effectively in person or online [32, 33].

An emerging area of interest in photovoice research relates to the environment, emergency management, and climate resilience planning [34]. In this context, investigators have solicited the experiences and perspectives of members of rural and indigenous communities recovering from severe rain and wind events [35], coastal fishing village residents experiencing climate-driven marine ecosystem changes [36], and women in Nepal facing mental health impacts from drought, water scarcity, and other climate related changes [28]. In work in a coastal setting in Australia, Chandler and Baldwin [37] described the use of photovoice as participants shared stories demonstrating community understandings of climate change effects and their capacity as a persuasive tool. Many of these studies have sought to understand the role of social capital in community resilience, and to explore its place in equitable climate governance [38].

In addition to co-producing new knowledge and developing potential solutions to local problems, the process of photovoice can build strength and resiliency within individuals and communities [23], while increasing social capital [38]. Additionally, the photovoice approach is responsive to the concerns, such as those expressed by members from Isle de Jean Charles, Louisiana, threatened by sea level rise, regarding the need for, and importance of,
community-led approaches and solutions [39]. As such, photovoice is “highly consistent” with the core principles of community-based participatory research, “stressing empowerment and an emphasis on individual and community strengths, co-learning, community capacity building, and balancing research and action” [40]. However, photovoice research also has gaps, limitations, and unintended consequences.

While photovoice can empower communities and individuals, the prioritization of cross-cutting community themes and dialogue [35] is often secondary to the individual stories and exhibitions, critical thinking during photovoice could be strengthened [41], and the process of generating solutions and advocating for collective priorities is seldom reported. Photovoice also often lacks external supporting data related to the topic of investigation (e.g., climate, health). While the goal of individual experience as essential to the creation of knowledge cannot be overstated, empowerment and improved decision-making may also benefit from additional education about the topic, and access to relevant data and the governmental departments generating and analyzing that same data. Indeed, photovoice rarely includes geospatial data as part of the process [34].

Derr and Simons [25], in their review of photovoice in environmental and conservation contexts, report inconsistent engagement with decision- or policymakers. This inconsistent engagement and potential lack of follow-through may lead to unintended consequences. For example, Pritzker, LaChapelle, and Tatum [31] found that although photovoice empowered youth, those same youth also expressed frustration at the perceived hypocrisy of adults around civic engagement. These findings highlight the need for ongoing discussions among community organizations and decision- and policymakers to enable the reinforcement of community narratives and implementation of desired solutions.

While photovoice is a powerful tool of place-based engagement, Russo et al. [35] further highlight a lack of clarity in how to best capitalize on its strengths, address its limitations, as well as the need for, and process of, engaging in comparative analysis across communities, a process that is further hindered by the lack of details provided about coding schemes and analytic techniques [34].

These limitations can diminish the effectiveness of photovoice for community action and advocacy. By viewing photovoice as a designed protocol of interaction [19–21] we anticipated and addressed the limitations described above with the integration of a design thinking component, which advances actionable potential through its framework for prioritization and problem-solving processes, an education module on climate change risk and geospatial mapping (including access to generate their own maps), and the inclusion of other community organizations and policymakers throughout the process to ensure meaningful and ongoing engagement.

Indeed, we see the lack of consistent engagement between community and policymakers in community-based approaches as a missed opportunity of stakeholder engagement. While photovoice research focuses on community participants as the primary stakeholders, we would suggest that the role of policymakers as stakeholders in the photovoice process should be reimagined. Rather than being brought in at the end of the process, engagement with the community throughout could strengthen policymaker commitment and buy-in to community-based approaches. Engaging with community organizations and policymakers from the beginning of the process allows all participants to interact over longer periods of time, rather than the one-shot interactions that occur in typical photovoice exhibitions. We see this as a way to help build relationships and commitment to community- engaged processes by policymakers (not just participants), letting them see how participants construct and talk about issues over a period of time. This also gives extended voice to community members with opportunities to engage at multiple times with policymakers.
Design thinking: Goals, current research, and gaps. The second element of our process, design thinking, provides a human-centered framework for participants to explore circumstances, conditions and opportunities, determine key challenges, imagine new opportunities to solve problems and reach ideal conditions, and build out a particular solution through facilitated activities. Associated initially with David Kelley, founder of the firm IDEO, and Stanford University’s Hasso Plattner Institute of Design (the d.school), design thinking has been widely applied in systems and product design as in the Cocreator Lab at Philips and IBM Design at IBM, and in business operations and products, as in the development of MassMutual’s Society of Grownups [42]. Liedtka describes design thinking as a social technology through which participants “collaborate and agree on what is essential to the outcome” [43, p. 79]. The premise of design thinking is that the process can be applied to any condition, and it begins with a close identification with the people most impacted by the outcome. The key steps of design thinking advance from an understanding of human needs and interests to the testing and prototyping of ideas in relation to their impact and effort. More recently, design thinking has been shown to promote critical thinking [44] and to be effective in bridging the gap between individuals and policymakers in conditions that lie outside conventional problem definitions [45].

The Stanford d.school design thinking process outlines five steps: Empathize, Define, Ideate, Prototype, and Test (https://www.alnap.org/help-library/an-introduction-to-design-thinking-process-guide), and is typically conducted in relation to a focus area selected by the organizers of the session. Empathy mapping builds from observation and engagement with users or the affected group. From these observations, team members define leading challenges and engage in ideation, a free-flowing process of imagining possibilities. Coalescing around a prioritized idea, a solution is developed as a storyboard or mockup, and finally tested across expansively defined users. Philips Design built on this method to develop their Cocreator Lab based on its “innovation and you” philosophy, seeking to establish a broader application of design thinking to organizations and collaborative problem solving.

In comparing process improvement to a design thinking orientation, Roberts et al. [46] noted that “process improvement prioritizes evaluation of limited set of possible solutions,” while design thinking “prioritizes comprehensive understanding of underlying problems.” They view this a distinct advantage in addressing “problems that have unpredictable solutions (wicked problems)” as design thinking encourages divergent thinking. Instead of focusing on what is significant to individuals within a defined context, design thinking seeks to discover what matters in daily life to a group. Mintrom and Luetjens [45] analyze the potential for design thinking as an added method for “policymakers to create interventions and services that improve the user experience and enhance public value.” They believe that the successful application of design thinking depends on a “diversity of skills and abilities,” as well as “curiosity and openness.”

Design thinking is used in multiple disciplines and for multiple problems. Academic literature on design thinking for climate adaptation often has a strong focus on the design of the built environment [47–49] or on specific policy or industry related innovation, such as Govaerts and colleagues [50] report on design thinking for Agri-food systems that are threatened by climate change. These processes tend to be top-down processes, led by experts or leaders focused on key problems, and largely engaging designers or experts. There is little published literature focusing on design thinking approaches to climate adaptation driven by community members.

Viewing design thinking as an engineered process of communication and engagement [19–21] allows for the modification and integration of the design thinking process with photovoice to help create a stronger approach to community-based climate adaptation approaches. Where photovoice encourages the discussion of themes within photographs, photovoice studies are often lacking in any collective approaches to problem solving, relying instead on individual
exhibition of stories and discussion with policy makers [41]. Design thinking offers a powerful complement to photovoice that encourages critical thinking [44], focuses on prioritizing issues and themes across participants, and enables a unique approach to problem solving. Although the design thinking process is often conducted via a top-down perspective, where policymakers gather participants to address a specific issue (see, for instance, 50), the HyLo method seeks to provide an alternative model that asks participants from the local community to bring their individual and collective issues (drawn from their photovoice stories) while gathering policymakers to engage with their process. In this way, the HyLo method retains the organic, grassroots nature of participant photovoice stories while providing a framework for communities to define and advance their collective agendas. Building on the themes residents identified through photovoice as the basis for design thinking, the direct experiences of community members determine the scope of topics engaged. The primacy and immediacy of the individual photovoice narratives inform the design thinking process to provide a community driven process of lived experience. The HyLo team’s involvement in the design thinking process focuses on the facilitation of ideas while the participants bring the content, priorities, and possible solutions. The presentation of photovoice stories through an initial exhibition lends both context and personal impact to the design thinking process.

Synthesized together, the design thinking processes of engagement, dialogue, and problem solving further support the underlying goals of photovoice of improving individual and community capacity, building social capital, and increasing agency. Additionally, the introduction of geospatial mapping at various points in the process provides community members access to data on social and climate assets and risks that many policymakers rely on to make decisions. The HyLo team has developed this mapping process into an Integrated Climate Risk Assessment (ICRA) tool which consists of multiple data layers with demographic, geologic, and infrastructure data for each neighborhood enabling access to a body of locally relevant information to guide in community-based policy planning. Finally, the inclusion of representatives from community organizations and policymakers throughout the entire process enables community member interaction over multiple sessions.

**Research questions**

Calls in the literature for additional community-engaged and local adaptation approaches [14, 15], along with limitations of scaled up approaches [16] suggest that local risks, needs, and perceptions vary by community. While community-engaged studies report on the perception of local risks, there is little comparative work examining variation between multiple community assessments of climate risk and adaptation possibilities at the hyperlocal level [35]. As such, we advance a series of research questions below. Research questions 1 and 2 focus on subjective concerns of individuals within the local environments and seek to understand whether local experience provides different perceptions of risk. Additionally, we view the showing and telling of stories by community members as inherently hyperlocal as they focus specifically on their lived experiences within their communities.

1. Do community members’ perceptions of climate change risk and their perceptions of the likelihood of those risks vary by community?

2. What are the key hyperlocal concerns related to climate change expressed by community members through photovoice? How do these concerns vary geographically by community? As discussed previously, many governmental decisions about adaptation are made based on city or county-wide geospatial data such as elevation or flood risk [e.g., 16, 22]. Research question 3 explores geospatial data to compare similarities and differences in risk factors in
communities within the same county. While the overall ICRA score is presented at both the county and community level, the visual representation of vulnerability on the maps demonstrates how risk can vary parcel by parcel or block by block, and provides greater understanding of hyperlocal risks from an integration of multiple vulnerabilities.

3. What are the risks of each community as identified by geospatial data in the ICRA? Community-based participatory approaches suggest that subjective community perceptions represent unique views into community risks, needs, and solutions. Research question 4 explores the relationship and alignment between community perceptions and risks identified with geospatial data. Differences in these perceptions would serve to highlight that significant concerns of community members may not be those most obviously identified by geospatial data—a finding which would reinforce the importance of engaging multiple sources of knowledge and data for decision-making.

4. What is the relationship between the subjective concerns of participants with the geospatial risks identified in the ICRA? While photovoice empowers the telling of individual stories, as detailed above, the process may not be as effective in developing solutions—an area where design thinking has demonstrated strength. As such, we ask research question 5 to see what solutions emerge from a design thinking perspective in our two communities. As with photovoice, we view these solutions as inherently hyperlocal as they focus specifically on the concerns advanced for a particular community, based on place-based needs encountered in everyday life.

5. What are the most pressing issues and potential solutions for these concerns as expressed by community members through design thinking? Do these issues and solutions vary by community? Finally, we seek to measure the impact of our process on individual and collective capacity. Photovoice theorizes that using this process of engagement within communities should increase engagement, advocacy, and connection; however, few studies measure the impact of the process on individual participants.

6. What is the impact of the HyLo method on perceptions of individual and community capacity?

**Methods and materials**

**Ethics statement**

Human Subjects Approval: This study was approved by the University’s Institutional Review Board, Approval # 20200182 (MOD00038843), modified to meet Covid-19 safety and online protocols. Informed consent was completed through an online process where participants read the consent form and agreed to participate in the study by clicking a box to proceed to the survey and online sessions. No identifying information was collected through informed consent, and all data related to online sessions was de-identified to protect participant confidentiality. Participant informed consent granted explicit permission for the use of photographs and stories for publication purposes.

**Study setting: Little River and Homestead in Miami-Dade County**

Miami-Dade County, located in southeast Florida, is one of the largest urbanized areas in the United States as of the 2020 Census. Its climate, topography, and sociopolitical environments individually and in combination make the county uniquely vulnerable to climate change.
impacts that include sea level rise, saltwater intrusion, extreme heat, intensified and more frequent storms, and increased number and scale of flood events. These impacts, however, and the efforts to prepare for them are not equally shared across the county.

As of 2019, Miami-Dade’s population was estimated at >2.7 million people, a majority of whom identify with at least one racial minority. Thirty-seven percent of the county’s households do not earn a living wage and an additional 17% are considered to be living in poverty [51]. Other social disparities include proportions of renters versus owners, median home value, and access to public services like transportation.

For this study, we focus on two communities: Little River and Homestead. Both are located in Miami-Dade County and share many of the same climate vulnerabilities as the rest of South Florida (sea level rise, hurricane risk, saltwater intrusion, etc.). We chose these two communities in collaboration with our community partners, The CLEO Institute and Catalyst Miami, because they have long-established relationships in these communities and each location represents a unique circumstance.

Little River, the site of The CLEO Institute collaboration, is a coastal urban neighborhood and Homestead, the site of a Catalyst Miami collaboration, is an agricultural community. Each community represents an ethnically diverse population with socio-economic and climate risks. Our determination of specific climate vulnerabilities was developed as part of the ICRA after the communities were chosen—but the selection of these communities focused on community resources as well as physical climate risk.

Little River is a neighborhood in the City of Miami that encompasses an area of approximately one square mile with a history that includes a Tequesta burial mound, signaling its long occupancy by indigenous peoples as well as subsequent inhabitation by generations of immigrants. Eponymously named after the river that runs to its north, Little River was established in the late 1800s and incorporated as part of the City of Miami in 1925. Adjacent to the Little River neighborhood are Miami’s Little Haiti, the Village of El Portal, and unincorporated West Little River. Little River is home to a population of 8,200 individuals, most of whom identify as Black or African American (78%) or Hispanic (18%). The median household income in 2021 was $21,809. The median age for Little River is 38.7 years. An average of 31% of units are renter occupied and 69% owner occupied (excluding vacant units). Among adults over 25, education levels are as follows: less than high school diploma (20%), high school diploma or GED (28%), some college (25%), bachelor degree (18%), advanced or professional degree (9%).

Homestead is a municipality in southern Miami-Dade County and the second oldest city and agricultural community in Miami-Dade. It is located southwest of the City of Miami and northwest of Key Largo. Adjacent to Homestead are Florida City and unincorporated Redland, Leisure City, Naranja, and Princeton. Homestead encompasses approximately 15 square miles and is home to nearly 70,000 individuals, most of whom identify as White (68%), Black or African American (21%), Hispanic (67%), and White, not Hispanic (11.9%) The median household income from 2015 to 2019 was $47,508 [52]. The median age for Homestead is 31.5 years. An average of 55% of units are renter occupied and 45% owner occupied (excluding vacant units). Among adults over 25, education levels are as follows: less than high school diploma (34%), high school diploma or GED (27%), some college (25%), bachelor degree (13%), advanced or professional degree (6%).

Geospatial mapping and the integrated climate risk assessment for Little River, Homestead, and Miami-Dade County

While photovoice and design thinking focus on participants’ subjective experiences of climate vulnerabilities, there is utility in relating those experiences to objective risks that may be used
by decision makers. Recent approaches to mapping and identifying risk suggest the incorporation of multiple factors into risk assessment, including social vulnerabilities, and identify challenges related to scale [22]. The Integrated Climate Risk Assessment (ICRA) addresses both issues of scale (we map risk variation at the level of 30 meters—allowing community members and policy makers to zoom in to see the different levels of risk that occur not only by city, but often by street, block, or individual parcel) and integrates physical, built, and social vulnerabilities through a model to evaluate and analyze geospatial climate risk factors of the Little River and Homestead communities. A broad array of 20 geospatial risk factors were assembled into a map model. Collected largely from public domain sources, these measurable risk factor map layers include average year built for residential dwellings, the prevalence of air conditioning, proximity to septic systems, housing density, groundwater level, depth to groundwater, vehicle availability, poverty, coastal flooding, greenness, surface temperature, flow accumulation, proximity to water, proximity to storm water features, slope, average household income, proximity to public transit, proximity to parks, elevation, and disability. These factors were chosen based on risk factors identified in the literature and conversation with academic, government, and community organizations. We recognize that these are subjective choices and that other factors may be seen as important, and hope this provides a model for how to create integrated risk assessments.

Using the Suitability Modeler in ArcGIS Pro™ GIS software, the values for each of the 20 risk factors were transformed on a scale of 1 (lowest) to 10 (highest) and added into a final unweighted ICRA score with 200 as the highest possible value or risk. The ICRA map layer was formatted as a raster dataset with a 30 m resolution, a scale which we consider to be in alignment with our hyperlocal approach, while mediating the varying scales of the assembled geospatial layers.

Not all geospatial data sets contained full geospatial coverage resulting in 47% of the county, mostly in the uninhabited Everglades, without an ICRA score. Of the remaining 53% of the county that was covered by the ICRA, an urban area of higher population density was delineated to analyze the situation of the Little River and Homestead study areas more accurately within the broader congruous geography.

The ICRA provides a tool to compare individual communities or neighborhoods on both individual and aggregated risk. For this paper, we relied on unweighted scores for each risk level, but the model is built to be adaptable to rankings based on community assessment of variables they view as most important for their local environments.

Additionally, we see the ICRA as a mechanism to compare the type of data policymakers often rely on to make long-term policy decisions to the experiences of community members as expressed through photovoice. This allows us to question whether the type of data presented in the ICRA aligns with the concerns of community members—providing insight into the relationship between community priorities and policy decisions. We believe this approach may enable greater opportunities for discerning more varied scales and approaches to climate adaptation.

**Procedures**

**Participants.** In total, 28 community members participated in some, or all, of the sessions, including 10 from Little River and surrounding communities, and 18 from Homestead. Of those who responded to our demographic questionnaire, our participants were majority female (n = 11), male(n = 2); reported diverse race/ethnicity—Black or African America (n = 6), White (n = 3), Hispanic (n = 9), other (n = 3); reported education levels as high school or GED (n = 1), some college (n = 4), college or technical degree (n = 4), master’s degree or
Participants ranged in age from 21–54, with a mean age of 34 years. Twelve participants responded that English was their first language while one responded that Spanish was their first language. Several participants indicated second language proficiencies, including Spanish (n = 5), English (n = 1), and Haitian Kreyol (1). Participants were split between renting and boarding rooms (n = 5) and home ownership (n = 6) with 2 participants not knowing or disclosing their housing status. Participants reported living in their community between 1 month and 18 years, with a mean of 8.3 years. The results presented below are derived from the 22 participants who participated in three or more sessions.

Overall, the demographics of the participants are fairly representative of the communities at large in terms of race/ethnicity, age, and home ownership versus rental status. Participants in our study reported higher levels of education and included a higher percentage of women than the roughly 50 percent ratio reported in both communities.

Sessions. Covid-19 forced a transition from in-person to online engagement. Sessions were conducted in collaboration with our community partners, The CLEO Institute and Catalyst Miami. The University of Miami HyLo team provided technical support by hosting Zoom meetings, assigning breakout rooms, collating photovoice stories, preparing, annotating and capturing design thinking slides, and assisting in facilitation where needed. Community partners led the sessions and served as primary facilitators.

With the shift to online workshops, we realized that interaction would be limited if all participants met in one large group. As such, we designed sessions around breakout rooms that were limited to four to six participants each. For the Little River sessions, we kept all six community members together who attended beyond the first session; for Homestead, we opened each session with all members together and then moved into four breakout rooms with four participants each. Additionally, members from city and county government, including the City of Miami’s Departments of Planning & Zoning and Public Works, and Miami Dade County’s Offices of Resilience, and Miami-Dade Department of Parks, Recreation and Open Spaces observed each session and engaged in discussion, where appropriate.

We opened with a joint session to introduce climate change concepts and the photovoice process to all participants. We held three subsequent sessions for each location—three for Little River and three for Homestead. We kept the groups separate for these subsequent rounds given their different locations and to enhance the potential for participants to form a sense of shared community and focus on local needs. Sessions included photovoice story presentations and discussion of common themes, an introduction to maps of local conditions relevant to photovoice concerns, and an introduction to design thinking, with a focus on discovery of experiences and frames for understanding. A second session of design thinking, through Discover, Framing, and Imagine (ideation and an impact-effort matrix to prioritize potential solutions) advanced to the closing phase of Build with relevant partners and actors identified. Discussion with key local and government leaders concluded the workshops.

Photovoice coding and analysis. While we provide illustrative examples of photovoice stories and narratives by community, coding and analysis was designed to provide different data than would normally be reported in a photovoice study, and to address concerns about transparency in coding reported in the literature [35]. Rather than focusing specifically on the narratives, our objective with this study is to compare key concerns across communities—and as such, systematic coding provides a mechanism for comparison [35]. To address specific concerns related to each community, we moved beyond the broad themes generated by participants in the sessions to develop a comprehensive set of primary and secondary codes (e.g., storms as primary, with wind damage, evacuation, and rainfall as secondary) related to climate change and adaptation. Photovoice stories were coded based on the most precise code for the story, and stories could have multiple codes. Additionally, photovoice stories were coded for...
their valence: positive (opportunity), negative (threat), or mixed (threat and opportunity). For each photovoice story, we coded the written narratives by first identifying the most prominent theme, then coded for each additional theme present in the narrative. To determine nuances in the stories themselves, we engaged in closer analysis that examined the patterns of stories and how primary and secondary themes wove meaning that is similar or different across communities. To do this, we examined each story for all codes to determine patterns within themes and subthemes.

**Design thinking data and coding.** Data for the analysis of design thinking comes from the annotated design thinking worksheets each group developed as they moved through the process. There is no current systematic method for analyzing design thinking data and processes. As such, we focus on the evolution of narrative and ideas as they progress through the process from Discover to Build. We let the themes and progressions speak for themselves through the broad presentation of data as it reflects both the logics and lived experiences participants incorporate in developing solutions to local problems.

**Measures for individual and community capacity.** To determine the impact of our process on community and individual capacity we created or adapted existing measures to assess community assets and risks and to evaluate the effectiveness and impact of our community engagement process in increasing: social connectedness, community engagement, individual agency, threat assessment, communication competence, and communication apprehension.

**Social Connectedness** measures the degree to which a person feels meaningful connection within their neighborhood [53] and was measured using an adapted 5-item Likert-type scale (strongly disagree to strongly agree) with reliability of Cronbach’s alpha = .87. Items include statements such as “There is someone in my neighborhood I could talk to about important decisions in my life,” and “I have relationships in my neighborhood where my know-how and ability are recognized.”

**Individual Agency** items were adapted from Shealy, Godwin & Gardner [54] and measured using a 5-item Likert-type scale with reliability of Cronbach’s alpha = .87. Items included such statements as “I can make my neighborhood stronger to deal with future climate change,” and “I can be a resource for my neighborhood for knowledge about future climate change and what we can do about it.”

**Communication Apprehension** was measured using four items from McCroskey [55], Personal Report of Communication Apprehension, and presented a reliability of Cronbach’s alpha = .55. Item analysis resulted in dropping two items which improved reliability to .71. Items included statements such as “Generally, I am comfortable while participating in meetings/group discussions about climate change;” and “I like to get involved in group discussions about climate change.”

**Communication Competence** was measured using three items from McCroskey’s communication competence measure [55] and had a reliability of Cronbach’s alpha = .90. Participants responded to the statement “Please indicate how good you would be at talking about climate change and what to do about it” for the following items: Talk in a group or meeting of friends or acquaintances; Talk in a group or meeting of strangers; Talk in a group or meeting with members of local government.

**Threat Assessment** items were adapted from “Florida: Public opinion on climate change” [56] and split into perceived threat and threat likelihood. **Perceived threat** from climate change was measured using two-items on a 5-point Likert type scale from 1 –not at all serious to 5 –very serious and had a reliability of Cronbach’s alpha = .92. Items included: How serious of a threat is climate change to you and your family? and How serious of a threat is climate change to your local neighborhood? **Threat likelihood** was measured using a 6-item Likert type measure on a 5-point scale from 1 –not at all likely to 5 –very likely and had a reliability of
Cronbach’s alpha = .89. Items included statements assessing the likelihood of neighborhood impacts from stronger and more frequent storms and hurricanes, droughts and water shortage, flooding, and sea level rise. Finally, the perceived timing of risk was measured on a 5-point Likert type scale ranging from 1—now to 5–100 years from now.

Neighborhood Asset Quality was measured using 10 items and had a reliability of Cronbach’s alpha = .98. Participants ranked what they liked (from strongly dislike to strongly like) about their neighborhood on items such as: housing (affordability and type), quality of local services, access to public transportation, and parks and open spaces.

**Results**

**RQ1: Do community members’ perceptions of the seriousness of climate change risk and their perceptions of the likelihood of those risks vary by community?**

Prior to the first workshop, participants assessed their perceived climate risk. Two-tailed independent sample t-tests indicated that participants from Little River (M = 4.60, sd = .699), as compared to Homestead (M = 3.38, sd = 1.204), had significantly higher threat perceptions for risk to family and community (t(24) = 2.911, p = .008). Additionally, participants from Little River (M = 4.833, sd = .192), as compared to Homestead (M = 4.35 sd = .985), had significantly higher perceptions of specific risk (e.g., storms, droughts) likelihood (t(24) = 2.197, p = .038). Examination of the likelihood of specific threats (see Table 1) shows that the participants from Little River perceived significantly more risk of saltwater intrusion than those from Homestead. While other areas of risk perception were not significantly different when tested individually, the patterns across all variables show higher risk perception, happening sooner, for Little River participants than for Homestead participants.

**RQ2: For each community, what are the key concerns related to climate change expressed by community members through photovoice? How do concerns vary geographically by community?**

The most important primary categories for stories from Little River were flooding (n = 4), with extreme heat, greenness, sustainability, and mobility all having equal numbers (n = 3 for each).

**Table 1. Means, standard deviations, t-tests, and significance levels of perceived climate threat.**

<table>
<thead>
<tr>
<th></th>
<th>Little River Mean(sd), n = 10</th>
<th>Homestead Mean(sd), n = 16</th>
<th>t-value df(24)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate risk to family</td>
<td>4.6(.70)</td>
<td>3.38(1.20)</td>
<td>2.91</td>
<td>.008*</td>
</tr>
<tr>
<td>Climate risk to community</td>
<td>4.5(.97)</td>
<td>3.31(1.08)</td>
<td>2.83</td>
<td>.009*</td>
</tr>
<tr>
<td>Storms</td>
<td>4.8(.42)</td>
<td>4.44(1.03)</td>
<td>1.05</td>
<td>.303</td>
</tr>
<tr>
<td>Droughts</td>
<td>4.4(.84)</td>
<td>4(1.03)</td>
<td>1.03</td>
<td>.315</td>
</tr>
<tr>
<td>Flooding</td>
<td>5.0(.00)</td>
<td>4.25(1.34)</td>
<td>1.75</td>
<td>.092</td>
</tr>
<tr>
<td>Sea level rise</td>
<td>5.0(0.00)</td>
<td>4.13(1.46)</td>
<td>1.89</td>
<td>.071</td>
</tr>
<tr>
<td>Saltwater intrusion</td>
<td>4.8(.42)</td>
<td>3.56(1.37)</td>
<td>2.77</td>
<td>.011*</td>
</tr>
<tr>
<td>Extreme heat</td>
<td>5(0.00)</td>
<td>4.44(1.09)</td>
<td>1.61</td>
<td>.12</td>
</tr>
<tr>
<td>Timing of perceived risk</td>
<td>1.67(1.12)</td>
<td>2.19(9.8)</td>
<td>-1.21</td>
<td>.238</td>
</tr>
</tbody>
</table>

Note: * = significance at .05 or less.

https://doi.org/10.1371/journal.pclm.0000041.t001
Homestead photovoice stories revealed different priorities. Sustainability (n = 11) and greenness (n = 10) were the top primary categories, followed by infrastructure (n = 6), storms (n = 5), health and wellbeing (n = 5), and extreme heat (n = 4).

One of the key themes of our work is that hyperlocal conditions vary, and that concerns are likely to vary as well. Our results showed evidence of both similarities and differences between key concerns from Little River and Homestead. Below (Table 2) we present the nuances in stories and themes around Greenness, Flooding, Extreme Heat, Storms, and Health and Wellbeing by analyzing the primary and secondary themes within each story.

Below are photovoice examples from the two communities that demonstrate differences in key themes between Little River (Fig 1) and Homestead (Fig 2).

RQ3: What are the risks of each community as identified by geospatial data in the ICRA?

The entire Miami-Dade County Urban Area (MDCUA) ICRA raster map ranged from risk scores of 57 to 127 for each 30 m pixel (Fig 3). The individual ICRA risk factors were rank ordered in relation to the Miami Dade County urban area (MDCUA) with the highest relative risk ranked first (Table 3). The average MDCUA ICRA score was 91.8, while the Little River and Homestead study area average ICRA scores were 98.6 and 94.9 respectively, revealing a higher objective climate risk for these communities when compared to the broader urban area in which they are situated, and a higher risk for Little River compared to Homestead. A more detailed examination of each individual objective risk factor of the ICRA indicates similarities and differences between Little River and Homestead in the top risk factors. Little River’s most prominent risk factors in rank order were: building year, air conditioning, septic, poverty, and average household income, whereas Homestead’s leading risk factors ranked as disability, average household income, poverty, elevation, and depth to groundwater.

RQ4: What is the relationship between the subjective concerns of participants with the geospatial risks identified in the ICRA?

Table 2. Examples of primary themes and subthemes by community.

<table>
<thead>
<tr>
<th>Primary Theme</th>
<th>Little River—subthemes</th>
<th>Homestead—subthemes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenness</td>
<td>Emphasis on issues related to shade to mitigate heat, especially in relation to public</td>
<td>Emphasis on open spaces, parks, playgrounds, and gardens, human impacts (trash,</td>
</tr>
<tr>
<td></td>
<td>transportation.</td>
<td>emissions, construction, pollution), and trees (or lack thereof), indicating a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>desire for more places for people to congregate and enjoy the outdoors while</td>
</tr>
<tr>
<td></td>
<td></td>
<td>reducing human impacts.</td>
</tr>
<tr>
<td>Flooding</td>
<td>Emphasis on rainfall, flooding, and the ability to get to work.</td>
<td>Emphasis on the ability to get to work, but also focused on human impact (including</td>
</tr>
<tr>
<td></td>
<td></td>
<td>issues such as infrastructure, construction, pollution), agriculture, extreme heat,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and food insecurity.</td>
</tr>
<tr>
<td>Extreme heat</td>
<td>No clear theme, but a range of issues such as shade, gardens, human impact, and trash.</td>
<td>Patterns of emerging themes around extreme heat related to crops, worker stress,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>storms/flooding, and food insecurity.</td>
</tr>
<tr>
<td>Storms</td>
<td>Emphasis on storms related to rainfall, traffic, flooding, and hurricanes.</td>
<td>Focused on hurricanes related to damage, safety, food insecurity, and crops, with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>additional emphasis on rainfall.</td>
</tr>
<tr>
<td>Health and</td>
<td>Only one story related to health and wellbeing, focused on insecurity and safety,</td>
<td>15 stories related to health and wellbeing, with themes around negative effects of</td>
</tr>
<tr>
<td>wellbeing</td>
<td>combined with SLR, hurricanes, human impact, and energy.</td>
<td>pollution, food insecurity, crops, extreme heat, worker stress/resiliency/fatigue,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and the impacts of pollution.</td>
</tr>
<tr>
<td>Valence</td>
<td>1 positive, 5 negative, 18 mixed</td>
<td>14 positive, 30 negative, 15 mixed</td>
</tr>
</tbody>
</table>

https://doi.org/10.1371/journal.pclm.0000041.t002
The key concerns related to climate change expressed by community members through the photovoice exercise grew organically from the participants and as anticipated, differed from the geospatial risk factors of the ICRA. Based, for example, on objective measures of greenness as identified by the Normalized Difference Vegetation Index (NDVI) and park proximity,
neither community ranked notably poorly in relation to the MDCUA average. Little River ranked 9th in risk for low levels of greenness, and 19th for low levels of proximity to parks. Homestead ranked 8th for low levels of greenness and 18th for park proximity. From an objective perspective, both study areas experience a slightly higher risk for low levels of greenness.

Fig 2. Homestead photovoice examples.

https://doi.org/10.1371/journal.pclm.0000041.g002

Hurricane season now lasts about half the year and summer storms are only getting worse. We keep our shutters up on some windows year round because it becomes easier to be prepared than to take them down for the short time we are not in hurricane season.

Rain leaves some flooding. Not just one, but multiple. It can affect the neighborhood walks, jogging, deliveries and bike riding. And, some might fall without proper shoes. Flooding also brings contamination and diseases. Floodwaters can carry raw sewage, leaked toxic chemicals, and runoff from hazardous waste sites. For example, on a Tuesday evening, a FedEx driver was dropping off a package at my house, and it was raining. He was still able to drop the package, but while walking towards the house he got his shoes wet and possible exposure to contamination and diseases. One does not know what flood waters can contain.

Monday July 13, 2020. Homestead temperature is 93°. Extreme heat can cause heat exhaustion, heat cramps, heat stroke, and death, as well as exacerbate preexisting chronic conditions, such as various respiratory, cerebral, and cardiovascular disease. My father for example, is a farmworker who works many hours to provide food and shelter. He comes everyday exhausted and out of breath, due to the extreme heat he faces daily, to the point, that he gets frustrated, discomforted and sick.

Dark clouds covers the sky. What climate are we in? In order to predict the climate several decades into the future, we need to understand many aspects of the climate system, one being the role of clouds in determining the climate’s sensitivity to change. Clouds affect the climate but changes in climate, in turn, affect the clouds. This relationship creates a complicated system of climate feedback, in which clouds moderate Earth’s radiation and water balance.
The Integrated Climate Risk Assessment (ICRA) combines 20 different climate risk factors: groundwater, surface temperature, water, storm water features, slope, septic, public transit, parks, greenness, flow accumulation, depth to groundwater, elevation, coastal flooding, vehicle availability, disability, poverty, building year, housing density, air conditioning, average household income. High values (red) reflect high risk and low values (green) reflect low risk.

Map by Abraham Kaleo Parish, University of Miami U-Link HyLo, 2021.

Miami-Dade County, FDEP, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS

Fig 3. Integrated climate risk assessment for Miami-Dade County.

https://doi.org/10.1371/journal.pclm.0000041.g003
than urban Miami Dade County, and both are at lower risk for low levels of proximity to parks. Residents in both communities, however, featured greenness as a significant area of concern, and identified greenness as a desired strategy, illustrating the potential for the community engagement process to serve as an important guide and integral part of designing climate adaptations that meet residents’ needs.

Similarly, objective measures ranked the risk of Disability at 12th for Little River and 1st for Homestead in relation to MDCUA. Using the ICRA to aggregate this data with average household income indicates that Homestead experiences significantly greater at risk for health and well-being than Little River. Integrating the photovoice and design thinking outcomes, reveals 15 photovoice health and well-being stories for Homestead compared to just 1 for Little River, and greater emphasis on mobility strategies proposed in the Homestead sessions.

The hyperlocal scale of the ICRA provide a further advantage for analysis through the illustration of a more detailed distribution of risk (Fig 4). The neighborhood of Little River, for example, represents a much higher risk than many of its surrounding neighborhoods or proximate municipalities such as El Portal. Similarly, the climate risk for the Laura Saunders Area of the Homestead study area is also high in relation to surrounding areas.

Table 3. Integrated climate risk assessment scores by raster layer and community.

<table>
<thead>
<tr>
<th>Climate Risk Factor</th>
<th>Scale</th>
<th>Miami-Dade County</th>
<th>MDC Urban Area</th>
<th>Homestead Score</th>
<th>Homestead Rank</th>
<th>Homestead Difference</th>
<th>Little River Score</th>
<th>Little River Rank</th>
<th>Little River Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>1–10</td>
<td>8.4</td>
<td>9.7</td>
<td>9.7</td>
<td>10</td>
<td>0.0</td>
<td>9.7</td>
<td>13</td>
<td>0.0</td>
</tr>
<tr>
<td>Slope</td>
<td>1–10</td>
<td>8.9</td>
<td>8.8</td>
<td>8.8</td>
<td>14</td>
<td>0.0</td>
<td>8.7</td>
<td>16</td>
<td>-0.1</td>
</tr>
<tr>
<td>Avg Household Income</td>
<td>1–10</td>
<td>8.7</td>
<td>8.0</td>
<td>8.7</td>
<td>2</td>
<td>0.8</td>
<td>8.6</td>
<td>5</td>
<td>0.7</td>
</tr>
<tr>
<td>Elevation</td>
<td>1–10</td>
<td>7.7</td>
<td>7.7</td>
<td>8.0</td>
<td>4</td>
<td>0.4</td>
<td>7.4</td>
<td>18</td>
<td>-0.2</td>
</tr>
<tr>
<td>Septic</td>
<td>1–10</td>
<td>4.8</td>
<td>7.6</td>
<td>7.4</td>
<td>19</td>
<td>-0.2</td>
<td>8.5</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>Depth to Groundwater</td>
<td>1–10</td>
<td>7.4</td>
<td>7.3</td>
<td>7.6</td>
<td>5</td>
<td>0.3</td>
<td>6.7</td>
<td>20</td>
<td>-0.7</td>
</tr>
<tr>
<td>Surface Temperature</td>
<td>1–10</td>
<td>5.7</td>
<td>6.5</td>
<td>6.7</td>
<td>6</td>
<td>0.2</td>
<td>6.7</td>
<td>10</td>
<td>0.2</td>
</tr>
<tr>
<td>Greenness</td>
<td>1–10</td>
<td>5.9</td>
<td>5.9</td>
<td>6.1</td>
<td>8</td>
<td>0.2</td>
<td>6.1</td>
<td>9</td>
<td>0.3</td>
</tr>
<tr>
<td>Groundwater</td>
<td>1–10</td>
<td>4.9</td>
<td>4.9</td>
<td>5.1</td>
<td>7</td>
<td>0.2</td>
<td>5.5</td>
<td>6</td>
<td>0.7</td>
</tr>
<tr>
<td>Building Year</td>
<td>1–10</td>
<td>4.4</td>
<td>4.8</td>
<td>3.4</td>
<td>20</td>
<td>-1.3</td>
<td>6.8</td>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>Air Conditioning</td>
<td>1–10</td>
<td>5.3</td>
<td>4.5</td>
<td>4.6</td>
<td>9</td>
<td>0.1</td>
<td>6.3</td>
<td>2</td>
<td>1.8</td>
</tr>
<tr>
<td>Parks</td>
<td>1–10</td>
<td>6.9</td>
<td>4.0</td>
<td>3.9</td>
<td>18</td>
<td>-0.1</td>
<td>3.5</td>
<td>19</td>
<td>-0.5</td>
</tr>
<tr>
<td>Disability</td>
<td>1–10</td>
<td>5.4</td>
<td>3.7</td>
<td>5.3</td>
<td>1</td>
<td>1.6</td>
<td>3.8</td>
<td>12</td>
<td>0.1</td>
</tr>
<tr>
<td>Poverty</td>
<td>1–10</td>
<td>1.8</td>
<td>2.1</td>
<td>2.7</td>
<td>3</td>
<td>0.6</td>
<td>2.9</td>
<td>4</td>
<td>0.8</td>
</tr>
<tr>
<td>Coastal Flooding</td>
<td>1–10</td>
<td>2.7</td>
<td>1.6</td>
<td>1.5</td>
<td>15</td>
<td>0.0</td>
<td>1.7</td>
<td>11</td>
<td>0.1</td>
</tr>
<tr>
<td>Public Transit</td>
<td>1–10</td>
<td>4.0</td>
<td>1.3</td>
<td>1.2</td>
<td>17</td>
<td>-0.1</td>
<td>1.0</td>
<td>17</td>
<td>-0.2</td>
</tr>
<tr>
<td>Vehicle Availability</td>
<td>1–10</td>
<td>1.0</td>
<td>1.1</td>
<td>1.1</td>
<td>12</td>
<td>0.0</td>
<td>1.5</td>
<td>8</td>
<td>0.4</td>
</tr>
<tr>
<td>Storm water Features</td>
<td>1–10</td>
<td>2.7</td>
<td>1.1</td>
<td>1.0</td>
<td>16</td>
<td>-0.1</td>
<td>1.0</td>
<td>15</td>
<td>-0.1</td>
</tr>
<tr>
<td>Housing Density</td>
<td>1–10</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>11</td>
<td>0.0</td>
<td>1.6</td>
<td>7</td>
<td>0.6</td>
</tr>
<tr>
<td>Flow Accumulation</td>
<td>1–10</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>13</td>
<td>0.0</td>
<td>1.0</td>
<td>14</td>
<td>0.0</td>
</tr>
<tr>
<td>ICRA 20–200</td>
<td></td>
<td>96.1</td>
<td>91.8</td>
<td>94.9</td>
<td>3.1</td>
<td>98.6</td>
<td>6.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Natural environment risk factors are shaded green, built environment risk factors are shaded purple, social environment risk factors are shaded orange.

https://doi.org/10.1371/journal.pclm.0000041.t003
Fig 4. Homestead and Little River integrated climate risk assessment.

https://doi.org/10.1371/journal.pclm.0000041.g004
RQ5: What are the most pressing issues and potential solutions for these concerns as expressed by community members through design thinking? Do these issues and solutions vary by community?

Our goal of design thinking is, in part, to advance from the individual concerns embodied in the photovoice narratives to perceptions of the most pressing concerns facing the community and to imagine an ideal future. The range of perspectives and ideas provide a foundation for the group to focus on solutions that can address multiple concerns. While the HyLo method introduces individual experience through the photovoice process, participants often inspire one another as they perceive other concerns they see as more pressing. While most of the issues discussed draw from the photovoice narratives, additional topics can emerge and resonate. For example, the issue of homeless populations and noise were raised in Little River design thinking. In Homestead, by contrast, Covid-19 and safety received significantly more discussion in design thinking than in photovoice, as did discussion around people and community.

Reviewing the results of the design thinking process in Little River and Homestead, the evolution from the narratives expressed through photovoice to action plans developed by each design thinking group evidences the emergence of practical plans to enhance daily life. The photovoice themes of greenness, flooding, extreme heat, storms and concern for health and wellbeing begin to take shape in plans for greening streetscapes and planting urban gardens, while floods, heat, and storm issues are addressed through methods for safer means of travel.

On the surface the connection between that second group of climate issues and their proposals may seem less clear, but as participants brought those larger topics into the focus of how their daily lives are impacted, the ability to get from one place to another came to represent an important concern, especially when work, home, school and essential provisions all require car trips. From that perspective, solutions that range from road repairs to shaded and sheltered transit stops, with multiple modes of mobility from green sidewalks and bike lanes to better busways and train service can be seen as a localized means of addressing climate change.

Table 4 indicates each group’s thought journey as they move from larger issues to daily life impacts to framing their key challenges to enhancing quality of life and identifying who would be needed to implement their ideas. Most notably, each group ultimately landed on engaging their own community members. While they also identified civic leaders and organizations, between their first iterations of issues and their final conclusions on who could help, they increasingly voiced confidence in their own powers for community transformation.

RQ6: What is the impact of our process on perceptions of community and individual capacity?

We conducted paired sample t-tests to examine changes on our variables of interest from before to after the workshop sessions. As we have a very small sample size these results should be seen as preliminary and interpreted as such.

Overall, we saw few significant changes, with threat perception approaching a significant increase from pre- \((M = 3.77)\) to post-test \((M = 4.41)\), \(t(10) = -2.219, p = .051\). Additionally, Social Connectedness saw a significant increase from pre- \((M = 12.50)\) to post-test \((M = 15.25)\), \(t(7) = -3.194, p = .015\).

While we had anticipated increases in personal agency and communication competence, and decreases in communication apprehension, the small sample size and the shift to online sessions from in person sessions likely created its own set of communication challenges. We are examining the protocols to make improvements for future sessions.
Table 4. Design thinking flow.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Little River</td>
<td>Flood, homeless, heat, rain, traffic, noise, engagement, community</td>
<td>Housing and employment, shelter, flooding and mobility, renewable energy, crime, green</td>
<td>Involvement, incentive planting, trash cans by transit, trees near transit, urban gardens, shade on playground, green jobs</td>
<td>Volunteers, local organizations, elected officials, parks and recreation, community members, schools, churches, art groups, farms and nurseries, Florida Power and Light</td>
</tr>
<tr>
<td>Homestead group 1</td>
<td>Development/green, flooding, vandals, consumerism, traffic, rent, hopeless, lack of awareness and compassion, ride sharing, congestion</td>
<td>Lack of awareness, housing/high rent, roads/traffic, reduce packaging, reduce traffic, educate community, petition government, incentivize electric cars, driving restrictions</td>
<td>Repair roads and potholes, more recycling bins, marketing campaign about resource use, extend train system to Florida City, revision of highways and transit, affordable homes, rent control</td>
<td>City planning, activists/organizations, architects, commissioners, community members</td>
</tr>
<tr>
<td>Homestead group 2</td>
<td>Traffic/construction, flooding, Covid/safety, mask mandates, timely completion of roads, more time with family, increased risk of accidents, sick family and friends, complain</td>
<td>Finish one project before new construction, vaccines, political leadership, mask mandate, work together, improved sewer system for flooding</td>
<td>Drive less, educate for kind drivers, educate storm readiness, policy to reduce driving, complete one project before starting another</td>
<td>City of Homestead, County commission, mayor, experts on driving etiquette, non-profits, public, lobbying firms/construction, tailored educational programs, students, teachers, other groups</td>
</tr>
<tr>
<td>Homestead group 3</td>
<td>Extreme flooding, farms sold, locals priced out, water pollution, hurricanes, high water, “Mount Trashmore” (landfill), power outages, air quality, extreme heat, difficulty breathing, skepticism of science, proactive for future generation, funding, lack of awareness, flood insurance, community buy in, drainage system, relocate “Trashmore”</td>
<td>Flooding, improved drainage, heat</td>
<td>Meaningful train routes to reduce traffic, carbon footprint, trash cans, solar, educate about hurricane preparedness, climate change</td>
<td>Mayor, teachers, elected officials, non-profits, students, social media, tik-tok, educate, neighborhood cleanup, bus stop shelters, energy efficient buses, irrigation systems, shade trees, traffic reduction, reduce carbon footprint</td>
</tr>
<tr>
<td>Homestead group 4</td>
<td>Overpopulation, traffic, stress, overbuilding without green spaces, trash, pollution, flooding, lack of concern, trees/shade</td>
<td>Too much traffic, trash, lack of heat resilience, need better transit, cleaner environment, green roofs and walls for comfort, work from home</td>
<td>Bikes, carpooling, walking, more sidewalks, improved infrastructure and shade, more busways, more park and ride lots, free service to busways</td>
<td>Department of transit and public works, commissioners, neighbors and community members, employers, transit alliance, use Facebook and digital tools for outreach</td>
</tr>
</tbody>
</table>

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Discussion

Overall, the results from our study show that participants living in two different neighborhoods in Miami-Dade County perceive and prioritize climate change risks in distinctive ways; further, in depicting their neighborhood, they expand the suite of well-known climate stressors (e.g., sea level rise, increased likelihood of hurricanes, higher average temperatures) to embrace a range of local issues of concern, such as access to transport, green space, and affordable housing. These local issues were represented in participants’ individual photovoice projects; for example, several Homestead participants included images and text about the impacts of heat on farmworkers; whereas some Little River participants pointed to the problems of sunny day (nuisance) flooding in parking garages and streets. As participants shared their photovoice images with one another and the workshop facilitators, and began to characterize dominant themes, they elaborated additional concerns which expanded beyond climate stressors. These concerns demonstrate the challenges of competing crises, some of which are immediate and affect day-to-day life more directly than long-term climate impacts. Further, these stories can highlight the gap between the priorities of neighborhoods and their representative governments–a disconnect that the Hylo approach seeks to address.
The design thinking portion of the workshop coalesced items of greatest concern to propose desired outcomes and viable paths forward with the input of community leaders. That residents of the two neighborhoods focused on different sets of threats and vulnerabilities underscores the importance of the hyperlocal approach to capture greater nuance than more conventional solicitations of public opinion (e.g., townhalls or public hearings). The combination of photovoice and design thinking also enables individuals first to contemplate issues in their neighborhoods that concern them, and second to hear, in a constructive space, the concerns of others. Having shared their lived experiences, participants are enabled by the design thinking process to envision, and with the partnership of community organizations and government agency representatives, implement desired outcomes, transforming the common practice of expert-driven, top-down proposals that seek community buy-in, into a community-based collaborative process. For policymakers, the potential to integrate the ICRA with workshop results can enhance the capacity to provide locally scaled initiatives.

Overall, our approach addresses multiple gaps in the literature. First, we address calls for improving methods of community engaged processes [e.g., 14, 15] by demonstrating how a unique integration of photovoice and design thinking—developed through the lens of communication design [e.g., 19–21]—can transform the shortcomings of each process as they are currently practiced into a more desired and normative process. Specifically, the HyLo method addresses two of the major limitations reported in the photovoice literature—engagement with policymakers and critical discussion [41, 44]. Our process builds relationships with policymakers from the beginning of the engagement, with members coming from the first workshop and, as their commitment grows, leveraging their connections to invite and include more (and more relevant) participation by members of other governmental offices in the final exhibition and discussion. The outcomes of this integrated process were evident as community members voiced their grievances and frustrations as well as their proposals for solutions, enabling policymakers to dive deeper into the concerns raised, gather additional information, and provide both immediate and long-range assistance.

Additionally, the inclusion of design thinking provides a mechanism to increase critical discussion around problems and solutions in ways that individual presentations of photovoice stories do not [41, 44]. When looking at the results of photovoice, we see primarily the reporting of the stories and narratives—reporting on critical discussions, moves toward solutions, or engagement with policymakers—are seldom reported. Additionally, through this process of integrating photovoice and design thinking we show how the process of design thinking can become a grassroots process focused on the lived experiences of community members. Through bringing their own experiences to life through photovoice, then using those narratives to drive toward solutions, the process is flipped from the typical top-down approach focused on a predetermined set of options present in many design thinking studies [47, 50].

In addition to the advances in community engaged processes that our method brings, we see this work adding to the growing body of knowledge focused on local knowledge and local adaptation. Specifically, our work addresses calls for comparative analysis of local communities through community based research approaches [35] and demonstrates how local perceptions of risks and needs vary within a larger decision-making geography. While the two communities in our study have somewhat similar risk profiles in our ICRA, the process of hyperlocal storytelling and design thinking show the variation in perceived risk and opportunity by community, and that there is room for adaptation beyond the large scale infrastructure approaches that are prevalent in South Florida.

This work also contributes to advancing the body of knowledge on mapping and the role of geospatial data in examining risk [22]. We demonstrate a process by which geospatial data on social, built environment, and physical risk can be combined to provide a different way to
assess community risk. While our communities were fairly similar on overall risk scores based on the ICRA, when looking at the visual representation of risk on the maps, it is clear that risk varies dramatically at the hyperlocal levels of neighborhood parcels or blocks. Additionally, we see the ICRA as a tool which can be modified to account for risk in different ways—with weightings of risk entered and adjusted based on evaluations by community members or policy makers. This would move the ICRA beyond an equal weighting for each factor, to a tool that could prioritize certain concerns. For instance, social vulnerabilities could be weighted more heavily to account for ongoing social or economic inequalities that affect individual and community ability to adapt to risk.

Challenges in community-based participatory research during a global pandemic

While we see valuable outcomes from the HyLo method, conducting community based participatory research during a global pandemic is not without challenges. Working in communities using digital and online tools reveals both opportunities and the presence of an ongoing digital divide and the limits of online collaboration tools. Recent research suggests that online convenedings for academic conferences have the potential to increase access and diversity in participation [57–59]. We saw definite advantages as participants were able to join in calls from home and even on their commute from work, relieving the burden of finding childcare or transportation to a central location, for example. However, some participants struggled with viewing and annotating on small screens, such as smart phones, struggled with submitting photos to the workshops, and had difficulty accessing digital mapping tools. While we provided trainings on these tools at the start of our workshops, new tools should be mobile device friendly, and facilitators need to be adept at finding workarounds.

We also found that a number of participants were interested in learning more mapping skills and in the brief time were able to identify some important intersections between climate and social data. We noticed throughout the sessions a progressive advancement of participants’ skillsets and increased levels of observation and assertiveness. We had not expected the degree to which participants, who had little to no experience with mapping, would be eager to engage with the online maps. This pushed our HyLo team to create a dedicated online map portal to enable ongoing participant access and to shift from static to interactive map engagement. County staff members are now also using this HyLo map portal in their resilience work. This experience has further inspired us to consider developing a protocol for integrating the photovoice work within the map sets to increase the ability to represent hyperlocal issues through geotagging and story mapping.

We had mixed findings on individual and community capacity, but even online we increased a sense of community connection and we see potential in this online format for increased individual and community capacity; at the same time, would appreciate an opportunity to measure whether engagement, connection, and capacity would improve in face-to-face workshops. While our method was able to tap into community concerns and provide voice to community members, we would seek to add a measure to assess impact on policy makers as well as to monitor implementation of long term solutions.

Conclusion

The HyLo method is grounded in an awareness that an urgent need exists for integrated, interdisciplinary knowledge to address the multitude and magnitude of conditions associated with climate change, and premised on the understanding that it is possible to elicit and map differential vulnerabilities that impact capacity to adapt [22]. Even more urgent, is the need for the
co-production with, and application of, knowledge by those most affected by current and future climate effects. This approach seeks to engage the community directly in observation, knowledge building, and the development of adaptation strategies. Further evaluation of the HyLo method and potential community-led solutions can inform further application in new circumstances. Outcomes can lead to hyperlocal adaptation initiatives that can ameliorate conditions for communities, providing climate responsive alternatives to improve daily local life that address each neighborhood’s unique concerns that are distinct from ongoing or forthcoming large-scale infrastructure projects. Long term, widespread utilization of this approach could result in a portfolio of hyperlocal adaptation solutions that can be matched to communities based on similarities across their ICRAs. This work provides a foundation for a new approach to policymaking through which the community becomes the change agent. The impact of this transformation would expand the landscape of climate adaptation and create opportunities for action at multiple levels, across domains, and with potentially powerful physical, social, and economic outcomes.

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