

## RESEARCH ARTICLE

# “Am I going to have to run to get out of this place?” A qualitative study exploring HIV clinical and service provider experiences from California regions heavily impacted by climate disaster

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## OPEN ACCESS

**Citation:** Moran L, Fuller SM, Joshi S, Outram S, Koester KA, Steward WT, et al. (2023) “Am I going to have to run to get out of this place?” A qualitative study exploring HIV clinical and service provider experiences from California regions heavily impacted by climate disaster. PLOS Clim 2(10): e0000269. <https://doi.org/10.1371/journal.pclm.0000269>

**Editor:** Akhilesh Surjan, Charles Darwin University, AUSTRALIA

**Received:** May 16, 2023

**Accepted:** October 4, 2023

**Published:** October 25, 2023

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**Data Availability Statement:** Due to ethical restrictions data are only available upon request. Our data consist of interviews with only 18 participants who work in a relatively small field, on teams that often have only one person in each role, and which include details and contextual information that could reveal the identity of the participants. Further, participants did not consent to transcripts of their interviews being publicly available. While these transcripts have been

## Abstract

Maintaining continuity of HIV care and prevention resources is critical to the health, wellbeing, and at times survival of individuals who rely on those services. In California, disaster events and extreme conditions caused by climate change are becoming more frequent and intense, impacting many regions in what have become cycles of destruction and disruption. The HIV workforce, already under strain, must now contend with delivering services to clients during and in the wake of repeated climate-related events. From October 2021 to April 2022, using purposive and snowball sampling, we interviewed 18 HIV, sexual health, and harm reduction clinical and service providers in California counties heavily impacted by climate-related events. Participants were asked about their experiences providing services amid climate disasters, including reflections on client needs and strategies for maintaining continuity of care. Data were analyzed following the tenets of thematic analysis. We found that HIV, STI, and harm reduction service providers and their agencies play an integral role within their communities, both in maintaining continuity of essential services to clients during catastrophic events, as well as in disaster response as trusted community resources. We further found that individuals in these roles drive the innovations and adaptive strategies that allow their agencies to endure the shock and disruption of disaster events. Finally, we highlight the extent to which clinical and service providers experience harms due to cyclical climate disasters. We discuss existing research on health system resilience in the face of climate change, and identify a critical research gap: consideration of workforce needs is often limited to professional skills and capacity specific to caring for climate disaster survivors, rather than as support needed by workforce personnel who are survivors of disasters themselves. We propose recommendations for next steps and encourage further research on HIV workforce resilience in a new climate era.

technically de-identified, there is no way to ensure that they are functionally de-identified given the highly contextualized nature of the personal experiences participants shared. Researchers who meet the criteria for access to confidential data may send requests for the interview transcripts to the Human Research Protection Program (HRPP)/IRB at the University of California, San Francisco at 415-476-1814 or [IRB@ucsf.edu](mailto:IRB@ucsf.edu).

**Funding:** This study was funded by the California HIV/AIDS Research Program, award number H21PC3238 to EA. The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

**Competing interests:** The authors have declared that no competing interests exist.

## Introduction

In the field of HIV, identifying, understanding, and working to minimize disruptions to HIV care and prevention resources—which include sexually transmitted infection (STI) and harm reduction services—is a primary research goal. As is true for many chronic conditions, people living with HIV require ongoing, consistent medical care. Studies have shown achieving viral suppression through antiretroviral therapy (ART) prevents transmission of HIV to uninfected partners and raises the life expectancy of a person living with HIV to nearly that of the general population [1]. However, a 2023 analysis of cohort studies [2] found these life expectancy projections are not a function of ART alone, but rely as well on sustained retention in care and effective management of comorbidities. Continuity of care is a critical component of HIV Care Continuum [3] goals to prevent new HIV infections and support people living with HIV to achieve and maintain viral suppression.

In addition to medical care, HIV care and prevention services often provide whole-systems—or wraparound—care to clients, such as social work, case management, linkage to primary care, housing support, safer sex or drug use supplies, and food and clothing resources, among others [4, 5]. For many people, particularly those at the intersection of multiple overlapping structural, social, medical, and economic vulnerabilities, the care HIV services provide meet essential needs [6], and disruption to those services can present a severe and immediate threat to their wellbeing.

## Climate change and health system disruption

Disruptions to health systems brought about by climate change have received increased attention in recent years as disaster events like wildfires, or climate conditions like extreme heat, have intensified in both scale and severity across the globe [7, 8]. Reports, toolkits, and government initiatives aimed at increasing health system resilience in the face of climate change have been developed and continue to evolve, focusing mainly on system-level vulnerability assessments, planning, and understanding patient needs relative to specific conditions [9–11]. While many such initiatives began over a decade ago, conditions have become more urgent in recent years.

In California, the increase in climate disaster events has been stark. Twelve of the 20 largest wildfires in California history occurred in the last five years on record (2017–2021) [12]. Of the 20 most destructive wildfires in California history, those that burned from 2017 to 2021 were responsible for more than three-quarters of the structures destroyed and nearly three-quarters of the deaths [13]. In 2020 alone, a record 4.3 million acres burned in California [14].

Wildfires are not the only climate hazard increasing sharply. A report published in November 2022 by the California Environmental Protection Agency (EPA), Office of Environmental Health Hazard Assessment (OEHHA) paints a picture of warmer air, drier conditions, more frequent and hotter extreme heat events, and increased flood risk. According to the report, *Indicators of Climate Change in California* [15], annual precipitation has become vastly more variable in the past four decades. Both extreme heat events (when temperatures are at or above the highest 5% of historical values) and heat waves (two or more consecutive heat events) have become more frequent in the past decade; eight of the 10 warmest years on record occurred between 2012 and 2022. In California and across the southwestern United States, 2000 to 2021 was the driest 22-year period over the past 1000 years, part of what scientists call an emerging “megadrought” era [15].

## The need for health systems to prepare for climate change

All essential functions of health systems, such as emergency and chronic care services, are vulnerable to shocks and changes, and globally, the need for health systems to prepare for climate

change has begun to garner more widespread attention [8–10, 16]. A 2020 scoping review of characteristics and descriptions of health systems offered a stark warning: that in the face of a major shock or fundamental change—not unlike the seismic shift that a new era of cyclical climate disasters would bring—health systems may collapse if they are not resilient [17]. Despite this, the authors further noted that health system resilience as a concept is neither clearly defined nor well understood.

### The healthcare workforce crisis

This urgent need for health systems to prepare for climate change, and the lack of clarity around what health system resilience to climate-related disaster would look like, are further complicated by multiple healthcare workforce crises. Prior to COVID-19, U.S. health workforce capacity was on a steady downward trajectory [18], and the pandemic has wreaked further havoc on the healthcare sector. Now, years into the COVID era, health systems and personnel are strained, exhausted, and under-resourced [19, 20]. The sector has suffered a massive reduction in labor supply since 2020 [21]. The HIV workforce, meanwhile, has been decreasing as demand for care has been increasing, with progressively fewer new clinical providers entering the field [22, 23].

### This study

After a particularly devastating year of wildfires in California (2021), we conducted a qualitative study to understand how climate-related events over the preceding 5 years had impacted the provision of HIV, STI, and harm reduction services in California. In this paper, we look specifically at the needs of those delivering this essential care. We explore the importance of these providers and their agencies within their communities, the essential role of individual service providers in adapting services to disaster conditions, and the impact that cycles of climate disaster are having on this workforce.

### Methods

From October 2021 to April 2022, we interviewed 18 HIV, sexual health, and harm reduction clinical and service providers in California to understand the impact of climate-related events on the provision of services, staffing, and client engagement in care. We employed a syndemic lens [24] which recognizes the connection between biological and social factors on health, and we recruited informants involved in the clinical or administrative provision of HIV, STI, and harm reduction services. We started with purposive sampling of providers known or referred to the study team by trusted colleagues in HIV services. We focused initial recruitment on counties impacted by major wildfires from 2017 through present, with special attention paid to counties with high prevalence of HIV and related epidemics. From there, we used snowball sampling to identify additional participants and additional regions impacted by climate events other than fires (e.g., floods, heavy smoke, extreme heat, major storms).

Potential participants were contacted by the first author via email and invited to participate. The email served as an introduction if the interviewer was unknown to the potential participant and provided explanation of the research and interview goals. If participants responded affirmatively, an appointment was scheduled for the interview to take place, conducted by the first author. Verbal consent was collected at the outset of the interviews. Interviews lasted 45–60 minutes and solicited participant perspectives on providing services during and in the wake of climate-related events, including discussing patient needs and strategies for maintaining care engagement through a disaster. All participants were offered an honorarium of \$75.00 at the end of the interview. Individual participants were free to decline the honorarium if their

employer's conflict-of-interest policies precluded receipt of an incentive for a research interview conducted in connection with the participant's professional role at the agency. The study protocol was reviewed by the University of California San Francisco Institutional Review Board (IRB #20–32214) and determined to be exempt from ethical approval.

Interviews were conducted and video recorded over Zoom, with the audio isolated and transcribed through a secure third-party transcription service. All transcripts were deidentified and participants given a unique anonymous ID number by researchers.

We did not have a target sample size at the onset of data collection; recruitment for further participants ended when no novel themes were arising from interviews [25, 26], as determined following review and consultation among study analysts.

## Analysis

We chose to conduct a thematic analysis [27], as our analytic focus was principally on the exploration of a phenomenon, and this analytic approach is well-suited to that goal. Thematic analysis allowed us to uncover in an open-ended way the dimensions of the challenges to providing HIV, STI, and harm reduction services in the context of cyclical climate disasters, from the perspectives of the participants involved. We employed robust structured qualitative methods, detailed below, in the analysis of the data, but the emphasis was on allowing the data to guide the development of new insights and understandings, rather than using a specific, established theoretical lens to interpret our findings.

Following the tenets of thematic analysis, the interviewer and one analyst developed a coding scheme based on *a priori* codes, deductive topics within the interview guide, and inductive themes emerging within the data itself. Once a coding scheme was tested and refined, the interview transcripts were entered into Dedoose [28], a qualitative analytic program, and all 18 transcripts were coded by primary and secondary analysts. The interview guide and code book are available upon reasonable request.

This manuscript represents findings from a subset of this previously coded data. For this analysis, we reviewed full transcripts and identified the role of the workforce as a significant emergent theme across interviews within the majority of our parent and child codes, such as services affected, service adaptation, demonstrations of resilience, facilitators to adaptation, worries, and challenges at the individual, organizational, community, and structural levels. We subsequently focused on coded excerpts related to or inclusive of workforce impact.

A small team of analysts (EA, LM, SJ) then read through narratives and met regularly for additional exploration and systematic analysis, with particular focus on the impact of climate related events on workforce, the health care delivery system, and sources of resiliency that translated into better care engagement. The first author then organized key narrative passages into more detailed analytic memos exploring patterns within these broader thematic areas. The team met regularly throughout this process, discussing and delving into the data to establish refined understandings across the data set, which are summarized in the results presented below.

Participants did not review their transcripts, but we shared preliminary findings with, and solicited feedback from, a California HIV/Hepatitis C/STI/Overdose prevention-focused coalition “Ending the Epidemics” consisting of several of our key informants and a set of policy stakeholders who helped us recruit our sample.

## Results

We interviewed 18 key informants from nine California counties in Northern, Central, and Southern California, serving catchment areas spanning 14 counties and two Native American

**Table 1. Participant characteristics by service environment and role.**

	N =	%
<b>Service environment</b>		
◇ Hospital systems	2	11%
◇ HIV clinics	4	22%
◇ County public health HIV programs	2	11%
◇ Harm reduction and HIV/STI prevention services (Testing, education, and outreach / syringe access, naloxone and fentanyl testing strip distribution, MAT)	5	28%
◇ Non-clinical service center (Case management, care coordination, food/housing support)	5	28%
<b>Participant role</b>		
◇ Clinician	4	22%
◇ Program staff or leadership (One whose primary role is the leadership, management, or coordination of an HIV program, clinical or non-clinical)	8	44%
◇ Service provider (Providing non-clinical social services, such as harm reduction, education, social work, case management, linkage to care)	6	33%

<https://doi.org/10.1371/journal.pclm.0000269.t001>

Reservations. Participants represented a diversity of agencies including large hospital systems, HIV clinics, county public health HIV programs, harm reduction and HIV/STI prevention services, and non-clinical service centers. Participants held a variety of roles that we have grouped into 3 categories: clinician; program staff or leadership; and service provider (non-clinical). Table 1 displays participant characteristics by service environment and role.

We found that the public health and community-based organizations represented in our sample served myriad roles within their communities and the individuals who comprised the workforce were driving the innovations and adaptations that allowed for continuity of care amidst multiple catastrophic disruptions. These roles were often far outside the scope of agencies' official charters and of particular importance during emergencies. We further found climate disasters to be exacerbating a workforce crisis, forcing staff and providers out of disaster-prone areas and creating conditions that prevent many of those who stay from doing their work. Furthermore, we found these constraints to be tightening while the needs of clients were intensifying. We explore these themes in more detail in the sections below.

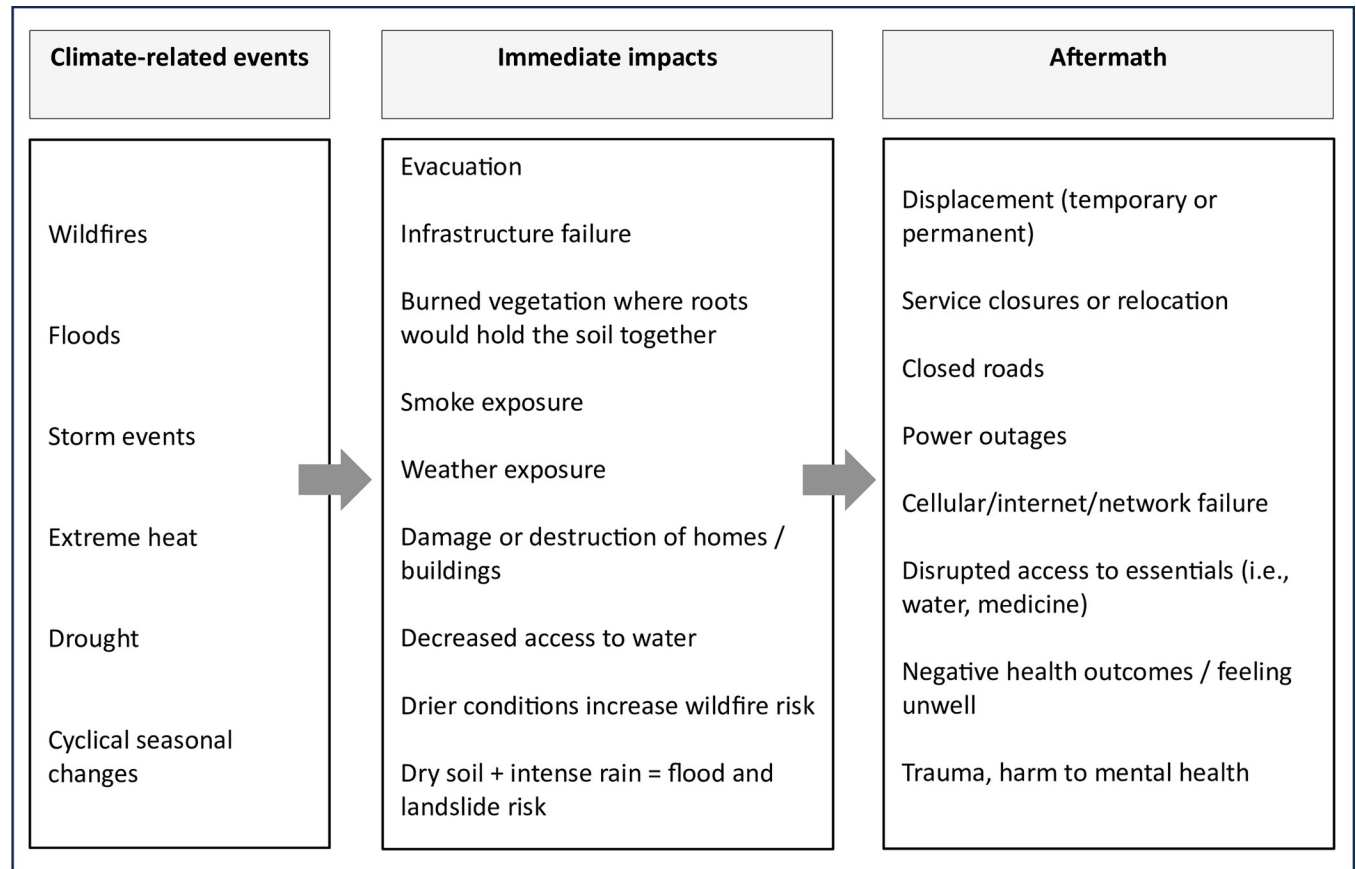
### Types of climate events

The types of climate-related events most commonly reported were wildfires, floods, storm surges, extreme heat, drought, and increasingly severe seasonal weather patterns. Participants noted not only the existence of these events, but their increase in both frequency and severity over recent years.

In the aftermath of these disasters, participants described a wide range of secondary crises related to short- or long-term displacement, unhealthy air, and damaged infrastructure including communications, roads, the electrical power grid, and water sanitation. Fig 1 presents a summary flow of climate-related events, immediate impacts, and aftermath, as reported by participants and consolidated across interviews.

### The roles of staff, providers, and their agencies

Across interviews, we found that providers and staff who deliver services through clinics and community-based organizations played crucial and multifaceted roles during and in the wake of climate-related events. Formally, they were responsible for maintaining clinical and service



**Fig 1. Summary flow of climate-related events and impacts, consolidated across interviews.**

<https://doi.org/10.1371/journal.pclm.0000269.g001>

operations to the greatest extent possible, and maintaining or reestablishing contact with clients to ensure continuity of care. Informally, they were the drivers of adaptation and resilience in the face of rapidly changing and unpredictable conditions. As members of the community, they provided far-reaching services, often outside their official scope of work.

**Resilience.** As participants shared stories of delivering care amidst cycles of climate disaster, personal resilience—the ability to cope and function within usual roles—and adaptability—the application of practical adaptive strategies in the face of emerging barriers—emerged as prominent themes. Participants highlighted how variable and unstable conditions could be in the unfolding wake of these events. The extent to which service provision was resilient was driven by the personal resilience and adaptability of staff and providers on the ground.

Scattered throughout interviews were stories of staff making in-the-moment adjustments or sparking innovation amid disaster conditions. One participant who serves in a leadership role with an HIV clinic (KI07) reported that whenever their area lost power or cell service, different teams in their agency would “step up to the plate,” going to see one another’s clients in person to give them information about new ways to connect with their provider, or an alternate time or place to get care. A clinician at an HIV clinic (KI08) spoke in detail about how their clinical team overlaid fire and evacuation maps with maps of their clients’ residences so that they could figure out in real time who was in danger and who was potentially out of communication reach. A program manager at a non-clinical client services organization (KI06) described a separate notebook the client services team had started to keep, compiling

information about the clients who would need the most immediate, hands-on contact in a disaster due to acute health or mobility issues, or isolation from people in their lives who could check on them or come to their aid. More than one informant reported using discretionary COVID-response funds to buy basic necessities for clients during multiple fires one season, while KI12, who holds a leadership position with a harm reduction program, reported using donations to buy tarps and hand warmers for unhoused clients trying to survive intense storm cycles.

One clinician recounted what they called “one of those apocryphal stories, but it was really true,” in which a wildfire led to widespread emergency evacuation, and short-term access to medication refills was an immediate concern:

*“One of our providers went to a local [drug store] and just stood by the pharmacy with a prescription pad and just offered to—I mean, not like, ‘Hey, get your [pain killers] here,’ but, ‘you need your Metformin or your Lisinopril?’ Just helping people . . . because it was a—you know, it’s a scary time.”* [KI10, clinician, HIV clinic]

Beneath these and many similar stories, the importance of the individual service providers in driving and operationalizing this resilience cannot be overstated. Essential information—like where to find clients during a wildfire that shut down the agency’s servers, knowing which clients had vulnerabilities that would put them in immediate or disproportionate danger, and understanding clients’ lives well enough to anticipate the challenges they would face—was rooted in the relationships and rapport that providers had built with their clients.

*“Even though we didn’t have access to client contact information, our team . . . knew the clients well enough. They knew where they lived. So, we were able to go out and check in on them. We were able to physically go out in our vehicles and check in and make sure the clients were okay.”* [KI14, program manager, non-clinical HIV service center]

**Embedded in community.** Our data highlight the extent to which participants, their colleagues, and their organizations are woven into the fabric of their communities. Participants described how their agencies have served as first responders and community centers, the places where people gather, the places where people receive essential services and get fundamental needs met, and the places on which people immediately rely in times of crisis.

It was not uncommon for informants to report providing 360-degree care and wraparound services to clients, regardless of whether those services were a part of their agency’s official charter. A clinician in a leadership position with an HIV clinic spoke about the unofficial role their clinic plays in their community:

*“We’re in a small community and we do have that perception—I mean, good or bad—that we’re like an urgent care, which we’re not. We try to really underscore, ‘We’re primary care,’ but still, I know it because I’ve been here for so long that people come in and are like, ‘Oh, I was at the restaurant and they said, “You got a sore throat? Go to the clinic.”’ That is and isn’t what we are but still, there’s that perception that we’re just always here.”* [KI10, clinician, HIV clinic]

Another participant runs a center that provides a menu of formal services, but informally provides essential services that not only extend beyond the scope of the agency’s official work, but also beyond the bounds of work hours and program funding. This participant (KI11) described doing informal case management for clients who shift on and off of Medi-Cal

(California's Medicaid program) and "scrounging" community networks to provide essentials like warm socks and sleeping bags for unhoused clients. They further reported providing transportation to clients whom they link to care but whose safety net insurance only allows them to receive care at a health center that is too far for them to travel to on their own: "We do have [an] FQHC [federally qualified health center] in our county but it's way at the other side of the lake from where most people are . . . 40 minutes one way, at least, if they weren't working on the road, which they seem to be for the next 400 years."

The founder of a community HIV services organization spoke more broadly to the importance of such programs to the communities in which they operate. They explained how their organization—and community-based organizations in general—function as first responders in a crisis:

*"Well, the thing of it is, who are the frontline people? Those are your community-based organizations. They're your churches. . . People are going to come to where they know first. And I'm going to tell you something, a lot of people, during COVID, they didn't have HIV and we still helped them. Because people just needed help. People just needed help. We have Red Cross, we have all these big, you know, . . . these huge, huge organizations that, amazingly, do help. But the frontline people are the CBOs [community based organizations]. We're the first people that the community comes to."* [KI16, program leadership, non-clinical HIV service center]

**Sharing climate-related impacts.** An essential tension arose in our data when analyzing the roles of participants within their communities. Being part of the communities they serve was critical to maintaining contact with and providing care to clients, but it also meant that providers were bearing the impacts of the same catastrophic events, trauma, and health risks brought on by the same disasters.

Despite representing different regions and perspectives across California, our informants painted strikingly similar portraits of the immense efforts—and tremendous strain—of providing HIV, STI, and harm reduction services in areas that experience cycles of disaster events and intensifying climate conditions year after year. We heard about staff and providers who had been evacuated or otherwise displaced during fires and floods, were living in areas where the commute to work was on roads that had become impassable, or were dealing with emergencies in their own lives or the lives of their families.

*"We live where we work. Almost everyone does. So that makes it hard to—to have care available to patients if we can't have staff, either because of a flood or a fire, that they can't get to the medical site where they need to do the work."* [KI02, program manager, HIV clinic]

*"We all live in the community. So, staff are stressed because they're either struggling with, my basement had 11 feet of water in it. So it's like my attention is split between how do we navigate what has to happen at the house and working in the clinic. And staff can have to leave the area, different things can happen."* [KI08, clinician, HIV clinic]

Nearly every informant spoke about this stress and the difficulty providers faced navigating personal emergencies while adapting to crisis conditions at work and forging paths to maintaining care for clients. For many, the mental and emotional strain was tremendous, and for some, particularly when paired with loss and instability, it was catastrophic.



*“The agency itself did not burn down, but my home burned down, and I had to relocate my animals to our actual agency, where they had to live for 15 months. . . . We also, a year later, had another staff member whose home burned down. Again, that was very disruptive, very traumatic. Then in the last two months, we’ve had another staff member’s home burned down, and it disrupted to the degree that this person has had to go out on disability.*

*She was homeless for a while living in a motel. There are waves. There’s just waves of grief if you will, and waves of inability to do one’s job.”* [KI07, program leadership, HIV clinic]

For many healthcare workers, the impacts of climate events on their own health have been compounded by the increased environmental exposure that comes with working in the field. One participant, who runs a program that provides wide-ranging HIV services, observed changes to outreach staff’s health over the course of multiple seasons of intensified patterns of alternating extreme heat and storm surges:

*“I think that combination [of environmental conditions] really created an effect for my staff who were going out into the field, and they were reporting having more fatigue and exhaustion, headaches, lethargy.”* [KI18, program leadership, non-clinical HIV service center]

Another participant from a small valley community where smoke and ash from nearby fires accumulate highlighted the ways that everyone in the community share a history of health sequelae and place:

*“A large [proportion] of people here have asthma from previous serious fire incidents where we were subjected to dangerous levels of ash in the air for long periods of time. I think they said there was a 50 percent increase in asthma diagnoses following [a major fire in the 1990s].”* [KI13, service provider, harm reduction services]

## Workforce depletion

Climate disasters are contributing to a workforce crisis among staff and providers doing essential work in HIV/STI care and harm reduction. Data from our interviews demonstrate the nature of this workforce depletion and explore impacts of a reduced workforce.

The cumulative effects of living and providing services in areas heavily impacted by climate events are contributing directly to the depletion of the HIV, STI, and harm reduction workforce. Participants reported observing this depletion in both the immediate aftermath of disaster events and in the longer term, raising concerns about the sustainability of serving rural communities, in particular, in the future.

As demonstrated above, participants recounted examples of clinical and service providers being unable to work due to climate-related events, either because they physically could not make it to work or were managing emergencies in their own lives. The mental health strain was a factor that has impacted providers’ ability to work in both the short and long term.

We further heard these disaster cycles had directly contributed to providers moving away altogether. Informants pointed, unprompted, to multiple examples of colleagues deciding to move out of state or to areas less prone to wildfires and other extreme climate events. KI08, a clinical provider and leader with an HIV primary care clinic, had seen a significant depletion in their practice:

*“They’re leaving because they’ve had it with fires and floods. I’d say I’ve had at least three providers leave in the last year because of that.”* [KI08, clinician, HIV clinic]

Some providers moved away after losing their homes. One HIV primary care clinician with a large health system (KI01) recounted a colleague from another region leaving the area after their house burned down:

*“Eventually, this provider just had to leave the area, because she lost her home. And I think with the threat of the future wildfires, she just moved out of the area. And so we had a big gap in care for people in that particular area.”* [KI01, clinician, hospital system]

Participants acknowledged these disasters and climate cycles had become a seemingly new ecological era in California, and the prospect of what that could mean for the future was alarming:

*“California just has been feeling extremely unsafe, and this is where I grew up, I’ve lived in other places, but this is where I thought I would spend the rest of my life. I sometimes go, ‘Am I going to have to run to get out of this place?’”* [KI07, program leadership, HIV clinic]

**Impacts of a reduced workforce.** The reduced workforce has had direct impacts on healthcare delivery in these regions in dynamic ways. This trend has led to fewer total providers to give care across service areas and job categories, and has led troublingly to fewer specialist HIV providers within accessible reach for some communities. As this has happened, the needs gap for affected client groups has widened. There are fewer people to deliver care as clients’ needs increase during and in the wake of disaster events.

Staff and providers who are unable to work in the short- or long-term and those who are evacuated out of the area present an immediate reduction to the workforce. As many HIV/STI and harm reduction agencies or departments are small, lost or diverted staff can mean a partial or entire suspension of services. One participant, a service provider for a harm reduction program (KI05), put it plainly: *“We were unavailable to be able to deliver any services to anyone until our evacuation order was lifted [and staff could return to the clinic].”*

Loss of specialty HIV primary care providers presented a unique challenge. Numerous participants, particularly those in clinical programs or case management, talked about the challenges involved in getting clients seen by available HIV specialists, some of whom represent the only HIV specialist within a multiple-hour drive radius. In our interviews, we learned of two separate providers who had been the only HIV specialists in their areas and who left their positions shortly after catastrophic wildfires. In the following excerpt, a participant described such a situation, its immediate impact on client care, and how strategies to maintain access to care had to keep changing in response to new barriers from additional wildfires:

*“So we lost our clinic in [County A] and I’m not sure if it was because of the fire, but they—their HIV specialty care provider quit. And we were going to take on [their clients] here in [County B]—meet them halfway in [Town A] at [a] clinic [there] . . . and that clinic is no longer there. . . . It burned.*

*So at the moment, those patients [from County A] will have to come all the way to [Town B], which they did once and they were not okay with it. They were very upset that they had to travel that far. That’s when we decided to try to hold it in [Town A] so it would be a little closer. And we held one clinic and they came, and then [another] fire happened. [Town B] is an hour and a half drive at least [from County A], but right now with the fire, with the road work, it’s about a two-and-a-half hour drive.”* [KI04, program manager, county public health HIV program]

Finally, participants spoke of healthcare delivery within the context of cyclical climate-related events as a whole-systems problem leading to a bidirectional widening of the service gap. The data set as a whole paints a picture of workforce capacity decreasing through staff attrition and unavailability while simultaneously, many clients' needs for services were intensifying. Providers described some of the ways climate-related disasters increased clients' need for support, clinical attention, and harm reduction services.

*"I think that with fear and depression and isolation, I think that substance abuse goes up quite a bit, I think people engage in risky behavior just—just—I don't—the isolation part I don't—I don't know how to word what I'm feeling, but it is—I see they almost look like different people when I see them. And—and I notice that they don't take care of their health as well. I notice that when things like the fire happens and they start to disappear, when they do come back, they're not as well as when I saw them last time. They are drinking more, they've called me—one client's called me crying saying, 'I'm going to use again,' and was very scared that he was going to use again, and I—I've never heard him like that. And, so, just—just their—their go-to during this panic, when they have nothing else and they have nobody else, is their drug of choice. And, so, I don't know. I think that during these emergencies, I think that that's their comfort."* [KI04, program manager, county public health HIV program]

## Discussion

Our data echo and elucidate a dynamic that has a growing evidence base: climate disasters precipitate or exacerbate health workforce attrition [29, 30]. This is particularly stark against a backdrop of existing scarcity; within HIV, we see much of the workforce retiring and aging out of practice, yet infectious disease fellowship programs are only filling half of their classes [22]. This will hit remote areas the hardest, further exacerbating physical and mental health disparities that exist between rural and urban populations, low-income and high-income areas, and majority-white and majority non-white communities [31–33]. In the context of climate change, there is the potential for the rural HIV healthcare workforce to be further hollowed out as climate events take their toll.

Loss to this workforce does not just represent compromised healthcare access overall—it is the loss of critical specialty care provided by an already diminishing workforce. Staff and specialist attrition from climate-impacted regions was especially notable to our informants because of existing provider scarcity and the lack of new personnel to replace them. Road closures due to wildfires, floods, landslides, or severe storm conditions threatened such dire consequences for care because so many people already had to travel burdensome distances to find the care that they need.

As climate problems continue to grow, the ability to offer in-person specialty care to people in certain parts of the state could be discontinued altogether. Health systems may be able to adopt virtual services, which offer tremendous avenues for access, but that will require that healthcare networks include providers who may be out of the local area. As problems continue to grow and the workforce continues to shrink, we can expect to see a gradual loss of healthcare services of any form from certain parts of the state.

Not all regions will be equally impacted. Remote and rural areas at the wildland-urban interface (WUI) are under the greatest threat of wildfires [34]. Many small, low-income, rural communities—often communities of color (majority non-white)—are dependent on water supply from a single source not connected to municipal water utilities [35]. Many low-income communities in California reside in areas without effective drainage capacity, rendering them

more vulnerable to floods and damage from storms [15]. Some regions will suffer a disproportionate burden of climate change, based on a complex interplay of geography, policy, and social, structural, and economic inequities—the same inequities that drive many of the disparities seen with HIV and related epidemics [36].

Meanwhile, researchers and policymakers have acknowledged the unique importance of the workforce in maintaining continuity of care during times of catastrophe or disruption [37, 38]. The World Health Organization, in their Operational Framework for Building Climate Resilient Health Systems, referred to individuals within the workforce as the keepers of “rich local information about risks, community capacity, and vulnerability that can help to guide the formulation of responses” [39].

In the climate change and healthcare space, however, what focus there is on healthcare resiliency looks mainly at infrastructure; the research lens has not yet been trained in any substantive way on the needs of the workforce or their role in strengthening health systems moving into this new era of cyclical climate-related disruption. When the workforce does appear in the literature, it is primarily discussed in terms of ensuring sufficient numbers of personnel and that those personnel be adequately trained in competencies specific to disaster relief and climate change [11, 40, 41]. Commonly, when researchers turn their attention to workforce support and development, they stop short of exploring the support providers may need not only as professionals, but as survivors themselves [42, 43].

This represents a critical gap in the research. Survivors of severe climate-related events and conditions have been shown to suffer profound physical, structural, neural, and psychological sequelae across the lifespan [44–47], with ramifications that extend well beyond those immediately impacted and the timeframe of the event itself [48–50]. Efforts to build workforce climate resilience that fail to view staff and providers as survivors of climate disasters will be unable to adequately understand the full scope of their needs.

The clinical and service providers interviewed for this study illustrate the extent to which community-based HIV, STI, and harm reduction service providers are embedded in their communities, providing multidimensional and far-reaching services often pertaining to clients’ survival-level needs. They spoke of their own experiences and the experiences of their colleagues, not just as providers of services during and in the wake of these disasters, but as survivors of the disasters themselves. Participants reported concern about their ability to continue to do their work in such conditions, and recounted examples of colleagues in their own spheres, some of whom were the only specialty care providers in their region, who fled the area in the face of home loss or an untenable future. Together, these findings suggest the ability of health systems to adapt to cycles of climate disasters in the long term relies in no small part on the continued service adaptation and innovation driven by individual providers, and on their personal resilience—their ability to cope with their own experiences of these disasters time and again.

It is for this reason the sustainability of continued adaptation and innovation under disaster conditions deserves special consideration. While our findings highlight the importance of resilience at the individual level, continued reliance on individual resilience alone is untenable. Our participants told stories of provider-driven innovation and adaptation *paired with* stories of strain, trauma, personal tragedy, and structural barriers that, taken together, do not suggest a sustainable path forward.

Recent critiques have emerged as well, questioning the emphasis on resilience at an individual level. In one such critique, the authors characterize resilience as an “adverse event,” a marker of trauma, and “an individual-level solution to a structural-level toxin” [51]. Indeed, in our study, health care workers were resilient because they had to be—serving their patients

required they overcome incredible hardship. This is an unsustainable and exploitative burden to place on a workforce.

Systems resiliency is different from individual-level resiliency in that it calls for structural, policy-level reforms to help clinics cope with changing circumstances, and thus takes the burden off individual providers to fill gaps in the system. This workforce will need support in two major ways: (1) to help its members cope with their own personal tragedies caused by climate events and conditions; and (2) to help ensure continuity of services during disasters. These services will require providing uninterrupted care for chronic conditions, care for disaster-related needs, and emergent care needs unrelated to the disaster.

### Next steps and recommendations

Moving forward, we recommend four parallel paths. First, we recommend identifying and leveraging existing frameworks for the development of further research with aims to better understand and meet the needs of those providing HIV, STI, and harm reduction services in regions highly impacted by climate-related events. One potential resource is the Griffith University Healthcare Workers' Resilience Toolkit [30], the first publication to date that has focused exclusively on factors affecting healthcare workers' needs and capabilities within the context of climate change. The toolkit provides guidance to leaders, policymakers, and health systems managers, addressing pre-disaster, mid-disaster, and post-disaster states. The authors based this guidance off interviews conducted with 13 Australian service providers who had worked through disasters. This work presents a useful framework, but the broader physical, structural, and mental health needs of healthcare workers within the context of climate change are not yet well-explored or understood. Further research is needed to build upon this evidence base and expand existing frameworks to the social and political context of the U.S. and the types of cyclical climate events seen in California.

In the short term, the second path is to look to existing and emerging research on the needs of climate disaster survivors, which we may then apply to a healthcare workers' resilience framework. While these studies have not so far focused on the workforce, our data illustrate health and social service providers are survivors themselves of the same disasters through which they support their clients, and can therefore be understood to be dealing with similar harms and have similar needs for support.

On a third parallel path, we must move forward understanding climate change to be a social determinant of health and both investigate and address workforce needs through this lens. Hwong [41] names climate change as "a societal problem, perpetuated by both public policies and social norms, that will disproportionately affect vulnerable and marginalized communities," while Valentine [52] stresses the importance of shaping policies related to climate change with an eye towards social determinants of health. We need to carefully consider what the unmet needs of local providers means in terms of the delivery of care and support services to clients with multiple intersecting vulnerabilities and long-term health needs. Right now, that work is falling to a dwindling number of providers who themselves often reflect the populations they serve (e.g., people living with HIV, people who use or have formerly used drugs), and navigate similar risks and vulnerabilities.

Finally, as a fourth path, we recommend exploring flexible sources of funding as a means of structural support for clinic and health personnel as they strive to meet the needs of communities during and in the aftermath of climate-related events. Flexible funding is vital given what is known, and what our findings reflect, about how climate disasters affect services and people's lives: displaced people need all manner of unanticipated assistance to access care or meet essential needs. Flexible funding would also allow agencies to provide to displaced clients from

out of a provider's network or refer clients to services afar. Providers who have more options and resources available need to pour less labor into creative adaptive strategies to meet their clients' needs.

### Strengths and limitations

The main limitation of this study is that these were exploratory interviews conducted to understand the impact of climate-related events on service provision broadly, and the focus on the workforce as a central theme arose gradually; our interview guide was not designed with this as an *a priori* theme.

Further, it is worth noting each informant had, at the time of their interview, chosen to remain in these climate-impacted regions, so our data do not include perspectives from people who left. Further research should study both care providers who practice in these areas and how to support them, as well as those who left, and what they would have needed to have stayed.

Additionally, we interviewed two informants providing services to Indigenous peoples on tribal lands. The data gathered from these interviews added depth and dimension to our main themes and are reflected in our findings. These service providers were recommended as part of snowball sampling, and it was critical that we include their perspectives. However, we acknowledge a depth and breadth of complexity in the relationships between climate, health, service provision, history, and policy on Native American Reservations that this study does not begin to plumb. There is much work to be done in this sphere that focuses on the experiences and needs of Indigenous peoples.

Finally, we must acknowledge that harm reduction services face social and policy barriers that are distinct from those faced by HIV and STI programming alone, and that the needs of those who work in harm reduction—often community members and/or volunteers—may be distinct as well. This study aimed to better understand the impacts of climate-related events on the provision of HIV and STI prevention and treatment services, of which harm reduction is a major part. However, this study does not explore the distinctions across service areas.

Strengths of this study include robust, collaborative qualitative methods and a sample selected purposefully, accessed via longstanding partnerships with colleagues deeply involved in the treatment and prevention of HIV and related epidemics, comprised of a diverse array of informants with rare expertise and experience.

### Conclusion

Healthcare workforce crises—generalized across the U.S. and specific to HIV, both exacerbated by the COVID-19 pandemic—have created a precarious baseline of workforce capacity. Recently intensifying cycles of climate disaster events in California has left a health workforce further depleted in both numbers and in human ability to withstand and sustain tremendous efforts without sufficient support. We contribute evidence of how HIV, STI, and harm reduction service providers and their agencies play an integral role within their communities, both in maintaining continuity of essential services to clients during catastrophic events, as well as in disaster response as trusted community resources. We further illustrate how individuals in these roles drive the innovations and adaptive strategies that allow health systems to endure the shock and disruption of disaster events. We further highlight the extent to which clinical and service providers experience harms due to cyclical climate disasters and identify gaps in the research where the specific needs of healthcare workers are not yet well understood in this context. Finally, we propose recommendations for next steps.

Future research that explores the physical, structural, and mental health needs of members of the healthcare workforce, how to meet those needs, and ways to build resilience within the healthcare system may be especially relevant as climate-related events continue to emerge and grow in their intensity.

## Supporting information

**S1 Checklist. Checklist of items that should be included in reports of observational studies with human subjects.**

(DOCX)

**S2 Checklist. Consolidated criteria for reporting qualitative research (COREQ) checklist.**

(PDF)

## Acknowledgments

The authors would like to thank the staff and providers who took the time to share their experiences with us, and the colleagues who assisted thoughtfully in recruitment.

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