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Disadvantaged Unincorporated Communities and the Struggle for Water Justice in California

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ABSTRACT: This article maps a meshwork of formal and informal elements of places called Disadvantaged Unincorporated Communities (DUCs) to understand the role of informality in producing unjust access to safe drinking water in California's San Joaquin Valley. It examines the spatial, racial, and class-based dimensions of informality. The paper aims to both enrich the literature on informality studies and use the concept of informality to expand research on DUCs and water access. We use socio-spatial analyses of the relationships between informality and water justice to reach the following conclusions: DUCs face severe problems in access to safe drinking water; disparities in access have a spatial dimension; inequities in water access are racialised; the proximity of DUCs to safe drinking water offers good potential for improved water access; and the challenges of informality are targeted through water justice advocacy and public policy.

KEYWORDS: Drinking water, human right to water, Disadvantaged Unincorporated Communities, informality, California

INTRODUCTION: DISADVANTAGED UNINCORPORATED COMMUNITIES, INFORMALITY AND WATER JUSTICE

The notion of access to water for drinking and sanitation as being a human right – not a privilege or a commodity to be bought and sold – is based on the understanding that water is essential for life itself and should not be subject to the dictates of the market (Gleick,1998). This understanding parallels other treatments of vital resources such as housing and healthcare and has been codified in multiple United Nations frameworks (Langford, 2005; United Nations, 2005; United Nations Committee on Economic Social and Cultural Rights, 2002).

Human rights have been less common as a basis for public policy in the United States, where the more limited concept of civil rights has predominated. This has begun to change, most notably with the passage of California's 2012 Assembly Bill 685 on the human right to water, which states that it is "the established policy of the state that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes". The passage of the Human Right to Water (HR2W) policy was the outcome of over a decade of organising and advocacy by residents, water justice organisations, and legislative allies (Goddard et al., 2021; Ramsden and Slattery, 2014). The HR2W policy now directs all state agencies to consider this fundamental right when adopting, revising or implementing regulations and funding programmes.

This policy has catalysed significant attention to situations where this right is beingviolated, which are often inhabited by low-income people and people of colour. In California, such places have been designated as Disadvantaged Communities (DACs) based on residents having an income of less than 80% of the state median household level. DACs that are both low income and located outside of incorporated city boundaries – called Disadvantaged Unincorporated Communities (DUCs) – have recently warranted special scrutiny.

DUCs in California and elsewhere risk significant violations of their human right to water because they often lack the political clout and economic resources needed to support adequate water infrastructure (Anderson, 2008, 2009). They tend to rely on under-resourced and underperforming public, quasi-public, private or self-provisioned infrastructure systems (Jepson and Vandewalle, 2016). This affects residents' access to safe and affordable drinking water, as well as access to other aspects of health and well-being such as adequate wastewater and sanitation systems, paved streets, and rain gutters (Alvarado 2020; Jepson and Vandewalle, 2016; London et al., 2018).

DUCs exist in many parts of the country, even if they are not always referred to as such. The terms Disadvantaged Community and Disadvantaged Unincorporated Community are used in California and will be used in this article. Unincorporated peri-urban areas along the US-Mexico border that are inhabited by disenfranchised Latino residents have been termed *colonias* (Davidhizar and Bechtel, 1999; Durst and Ward, 2016; Jepson and Vandewalle, 2016). Similar communities exist throughout the United States,

especially in predominately Black communities in the Southeast, and areas in and around Indian reservations (Blomquist et al., 2004; Leker and Gibson, 2018; Middleton, 2010; Morrone et al., 2011).

This article focuses on the DUCs in California's San Joaquin Valley (henceforth, 'the Valley'), a site of profound social and environmental injustice (Cole and Foster, 2001) While there is a rich literature on water conflicts and injustices in the Valley (Balazs et al., 2011; Balazs and Ray, 2014), this is the first study to focus specifically on DUCs in this region and to provide an in-depth analysis of their unique demographics and of the barriers in access to safe water that are related to their informal status. DUCs are an important research area for scholars of water systems and environmental justice because of the extreme risks experienced by residents, the challenges of designing public policies to mitigate these risks, and the creative organising and advocacy by residents and water justice organisations that pushes public agencies to protect the human right to water through formalisation of these communities. In particular, DUCs represent a unique opportunity to understand water governance in contexts where no municipal government is in place, and to examine the conditions of precarity which affect the most marginalised people and places.

To frame the analysis of the unincorporated status of DUCs, we turn to the concept of informality. This refers to the condition in which certain people and places exist to a substantial degree outside the direct authority and responsibility of formal state and market institutions (Roy, 2005). We do not suggest a strict binary relationship between formal and informal communities and will apply recent scholarship on concepts such as 'meshworks', or hybrid systems of formal and informal components (Schwartz et al., 2015). We seek to enrich the literature on informality studies and to use the concept of informality to build on the research on DUCs in the United States and in other high-income countries.

To this end, we ask four research questions:

1. What are the conditions of access to safe drinking water in DUCs?
2. What are the spatial, racial and class dimensions of these conditions?
3. What is the role of informality in explaining these conditions?
4. What are the social movement and state responses to the problems of informality?

To answer these questions, we draw upon mixed methods empirical data from a recent study of DUCs and safe drinking water access in the Valley (London et al., 2018). We examine the ways in which informality – coupled with spatial patterns, race, ethnicity and income – serves to produce inequities in access to safe drinking water. We adopt a meshwork notion of informality that recognises the interweaving of formal and informal elements of the water provision and governance systems in DUCs (Ahlers et al., 2014; Schwartz et al., 2015). While we do not pathologise the status of informality, we do document the ways in which unincorporated status materially and discursively disadvantages communities in their pursuit of water justice.

Following a section that provides a theoretical framework, we describe the study research methods. We then lay out the five primary findings:

1. DUCs face severe problems in access to safe drinking water;
2. There is a spatial dimension to disparities in access;
3. Inequities in water access are racialised;
4. Proximity of DUCs to safe drinking water supplies in formal water systems offers good potential for water access;
5. The challenges of informality can be effectively targeted through water justice advocacy and public policy.

THEORETICAL FRAMEWORK: MESHWORKS OF WATER ACCESS, INFORMALITY AND JUSTICE

Informality describes a marginalised social position relative to state-sanctioned economic and political systems (Hart, 1973). Informality is in some ways defined by what it is not (that is, formal), but also by its dynamic and mutually constitutive relationships with the formal sphere (Roy, 2005). Because of its potential for explaining disparities in water access, quality, cost and governance, the concept of informality is valuable in framing the study of water justice and DUCs.

The concept of informality emerged in the 1950s and 1960s as scholars sought to understand the social and economic implications of rural-to-urban migration in lower-income countries that were in the process of decolonising; this included an examination of the production of inequality in the informal employment sector and in peri-urban settlements (Hart, 1973; Moser, 1978; Portes et al., 1989; Bayat, 2000; AlSayyad, 2004; Roy, 2005). This work studied the relationships among labour sectors and considered the implications for workers who were outside formal employment systems. The informal sector was seen as marked by exploitation and exclusion which were manifestations of vulnerable labour relations, lack of citizenship rights, and the peripheral and under-resourced nature of communities (Hart, 1973; Revell, 2010). Informality was framed as a product of uneven development and dependency, which were unleashed by predatory forms of capitalism, neoliberalism and neocolonial exploitation (Kooy, 2014; Kudva, 2009).

While acknowledging the unique challenges facing informal communities, Roy (2005) challenged the stark dichotomy between formal and informal domains. Launching a compelling turn in the literature towards the intersections and mutual dependencies of the formal and formal sectors, Roy (2005) depicted informality as being comprised of complex continuums between legality and illegality, legitimacy and illegitimacy, and authority and anarchy. According to Roy, informality was not to be seen as a condition of exception outside the bounds of the state, but instead as something that was necessary to its construction, operation and logistics.

Rather than situating the informal sector as an aberration from the formal, some scholars position informality in certain settings as a dominant form (Revell, 2010; Ranganathan, 2014;). In these cases, informality is an adaptive response to dysfunctional and exploitative state and market institutions, providing 'work-arounds', resistance and collective self-provisioning for vital resources and services. Planners and policymakers who understand the importance of informal communities are called upon to recentre informality as integral to peri-urban spaces; from this follows the prioritisation of investment in marginalised people and places, coupled with support for their political agency (Liddle et al., 2016).

There is extensive scholarship on the ways in which informality leads to disparities in access to drinking water, including that by Kooy, (2014); Ranganathan and Balazs, (2015); Liddle et al., (2016); Wutich et al., (2016); and Enqvist et al., (2020). Throughout this paper we will define formal systems as those providing piped water from publicly or privately owned and operated water wells, reservoirs, or surface water canals; typically, these are regulated by the state. Informal systems – which have little or no state regulation – can include domestic wells, water tankers, water from vendors, bottled water, or unauthorised water tie-ins to formal systems (Ahlers et al., 2014; Schwartz et al., 2015). In many cases, informal water systems receive inadequate quantities and poor quality of water; its users also tend to be excluded from decision-making and are stigmatised as backward and even threatening to 'formal' and 'modern' systems (Ranganathan, 2014)

Following Roy's challenge to the strict formal/informal dichotomy, many accounts of water inequity highlight the intertwined relationships between formal and informal systems (Bakker, 2003; Loftus, 2007; Misra, 2014; Peloso and Morinville, 2014). In unincorporated communities, there is often a coexistence, co-production, and intersection of formal and informal water systems (Ahlers et al., 2014; Schwartz et al., 2015); these must be understood as existing in a complex matrix of social relations and physical infrastructure (Ward, 2010; Vandewalle and Jepson, 2015;). The concept of a 'meshwork' (Schwartz et al., 2015) has been applied to the ways in which formal and informal water provision systems are joined

together in an interdependent web. Understood in this way, water systems are co-productions of formal and informal modalities of water procurement, treatment, transportation, storage, purchase and consumption (Ahlers et al., 2014).

The concept of the meshwork is valuable in illustrating the complex landscape of formal and informal elements in DUCs; in such environments, no municipal government owns and oversees the water utility, and residents may obtain water through an array of other institutional arrangements which can include a relationship with nearby local governments, procurement from investor-owned water companies, the formation of cooperatively owned water companies, and/or self-supply through domestic wells and vended water (Wutich et al., 2016; Pierce and Gonzalez, 2017a, 2017b). In some cases, DUCs are served by their own water system, while in other cases residents purchase water from private utilities or wholesalers. In cases where there is no formal state-regulated system, residents rely on informal sources as defined above (Jepson and Vandewalle, 2016; London et al., 2018).

The concept of the meshwork can also help explain how these patterns can lead to inequitable conditions of water access in DUCs. As Schwartz et al. (2014: 35) state, "The meshwork is not neutral. The ability of different actors to influence and benefit from the continuous process of producing and reshaping the meshwork is dependent on the authoritative resources that they have".

Despite the utility of the meshwork concept, the present study does not fully accept the premise of some scholars that the meshwork prevents any distinction between formal and informal water provision (Ahlers et al., 2014); instead, we find it important to view these conditions as distinct yet interrelated. Similarly, unlike some accounts that strongly valorise the informal elements of water provision systems (ibid), we view informality as largely an impediment to achieving water justice. Indeed, most advocacy by and on behalf of DUC residents in the Valley to achieve California's human right to water involves efforts towards formalisation, either by consolidating low-functioning water systems with higher capacity systems, annexing the former into the latter, or expanding formal system boundaries to include areas with no water system (Green Nylen et al., 2018; Hansen et al., 2020). While we recognise that in the absence of formal water provision, informal elements of water provision can provide valuable water access, we do not view it as an adequate level of water service; furthermore, due to its unreliability in ensuring an adequate quality, quantity or affordability of supply, we also do not view it as a complete form of protecting the human right to water.

The uneven achievement of the human right to water in the Valley's DUCs is the result of multiple factors. Alvarado (2020) and other scholars examine the deep historical roots of the implicit and explicit racism that produced, and continues to marginalise, unincorporated communities that are inhabited by low-income people and people of colour in California's San Joaquin Valley and elsewhere. Exclusion from city boundaries means exclusion from essential municipal services including drinking water, sewers and sanitation (Anderson 2008, 2009; Alvarado 2020). DUCs enveloped within cities or on their fringes are a product of urban segregation, redlining, and racialised exclusion from public benefits that occurred as people of colour were pushed into marginalised spatial and social conditions in, and just outside of, city limits (Dymski, 2006).[1] Other DUCs were settled by industrial and service workers and by farmworkers, all of whom were attracted to the low housing costs and lack of racially exclusive policies and practices (ibid). Some remote and very remote communities have their origin in the settlement of informal farmworker camps far from city limits. In these areas, workers depended on farmers for housing and basic needs, and often lived in degraded and exploitative conditions (Goldschmidt, 1947; Martin and Taylor, 1998; Eissinger, 2015).

[1] Redlining refers to a practice used throughout the United States between the 1920s and the 1960s whereby home and business loans in areas deemed 'risky' were restricted by insurance companies (and coloured in red in investment maps). Part of the determination of risk was based on the presence of people of colour; those home and business owners were thereby deprived of needed capital which, in turn, created a self-fulfilling prophesy of neighbourhood decline (Rothstein, 2017). Formerly redlined areas continue to suffer from economic and environmental inequities.

This exclusion from city services leads to a dependence on surrounding counties for infrastructure (Rubin et al., 2007; Flegal et al., 2013; Alvarado, 2020); many counties, however, have had policies which intentionally deprived these unincorporated communities of basic investments in order to force their residents to move (Pannu, 2012). Despite these attempts at forced attrition, however, many residents remained in these communities because of family and place-based bonds and because of their inability to afford housing in cities; they continue, therefore, to live under conditions of deprivation. This pattern of urban segregation and rural dis- and non-investment in DUCs has created a condition of underdevelopment and has entailed violations of the basic human right to water.

METHODS

Case study site

The San Joaquin Valley is an appropriate site to study water justice because it exhibits stark contrasts between the wealth of its agricultural and petrochemical industries and the poverty of the people who produce this bounty (Goldschmidt, 1947; Martin and Taylor, 1998). The Valley has been described as an internal colony of California's coastal centres of capitalist development and its global extensions (Walker, 2004). It is consistently ranked as one the highest-grossing agricultural regions of the country and the world, and is driven by massive infusions of pesticides, fertilisers and irrigation water (Walker 2004; Arax, 2019). At the same time, it has the worst air pollution in the country (American Lung Association, 2020), has among the nation's highest poverty rate (Joint Center for Political and Economic Studies, 2012), and groundwater that is polluted by the effluent of the region's agricultural and other industries (Burow et al., 2008; Harter, 2012). In order to provide a holistic way of understanding the production of water injustice, Balazs et al. (2011) examined the patterns and causes of racialised disparities in exposure to nitrates in drinking water, while Balazs and Ray's (2014) Drinking Water Disparities Framework integrated elements of the natural, built and sociopolitical environments. This study draws on the literature on water injustice in DACs in its examination of the extreme case of DUCs.

Study design and research collaboration

The study by London et al. (2018), on which this article is based, was developed in collaboration with several California-based environmental justice organisations. A coalition of water justice organisations and funders approached the academic researchers with a request to document water access conditions in DUCs to inform water justice campaigns. As a community-based participatory action research (CBPAR) project, our research was informed by the water justice advocates so as to ensure that content was relevant for their campaigns. This paper is thus authored by both the academic and advocacy partners in the project. This follows a common CBPAR approach which aims to enhance the rigour and relevance of the research, as well as its reach to inform policy and social action (Balazs and Morello-Frosch, 2013).

Designation of DUCs

This study drew from an approach developed by the non-profit research organisation PolicyLink and its partners to identify DUCs in the San Joaquin Valley (Flegal et al., 2013). We collaborated with PolicyLink to use their DUC dataset, which used three metrics to determine DUC status: 1) low-income neighbourhoods with a median household income (MHI) of less than 80% of the state MHI (disadvantaged status); 2) unincorporated status outside of city limits, and 3) parcel density of at least 250 parcels per square mile to identify community-scale settlements. The final dataset identified 450 distinct DUCs in the 8 counties of the San Joaquin Valley.

To assess the disparities facing DUC residents, we compared them against three other types of communities: non-disadvantaged Census Designated Places (non-DAC CDPs), Disadvantaged Cities (DAC cities), and non-Disadvantaged Cities (non-DAC cities). We derived these datasets from the U.S. Census

Bureau 'Places' geography, which displays boundaries and characteristics for incorporated places (cities or towns) and Census Designated Places (CDPs). Non-DAC CDPs are unincorporated population centres that have no formal legal incorporation status, but which are enumerated in the census because they have a social identity and statistical utility as the counterparts of incorporated places (US Census Bureau 1994). DUCs can be considered a subset of CDPs; as such, they are used as a proxy for DAC CDPs but with higher resolution due to the parcel-level data used by PolicyLink.[2] We use incorporated places data to establish the two remaining community types.

Unlike DUCs, non-DAC CDPs have incomes above 80% of the state MHI;[3] they tend to be suburban and rural developments such as gated and golf course communities. DAC citiesare incorporated self-governing areas that, to be considered 'disadvantaged', must have MHIs below the 80% threshold of state median household income; non-DAC cities, on the other hand, have MHIs above this threshold. In the Valley, there are 56 non-DAC CDPs, 44 DAC cities, and 18 non-DAC cities; these are in addition to the 450 distinct DUCs in our sample, as mentioned above.

Sociodemographic calculation

The study used the 2010 census block-level data for race and ethnicity because it provided the most accurate population count at a fine scale. It used the American Community Survey (ACS) 2013-2017 five-year dataset for data variables such as MHI, which were not calculated at the block level in the 2010 census. We used the ArcGIS summary geoprocessing tool to aggregate ACS and decennial census data (that is, MHI, race and ethnicity) by incorporated cities and unincorporated areas (CDPs), and further by disadvantaged unincorporated areas. This provided a reference point with which to compare the different geographies to each other and with which to compare each DUC to the San Joaquin Valley as a whole.

Proximity of DUCs to city boundaries

We used an ArcGIS geoprocessing tool to determine the proximity of DUCs to city boundaries. This provides the terminology that is used in several analyses for the different types of DUCs: 'island' (city boundary within 500 feet/ 152 metres), 'fringe' (city boundary between 500 feet and 1 miles/ 152 metres and 1.600 kilometres), 'remote' (city boundary between 1 and 3 miles, /1.6 to 4.8 kilometres), and 'very remote' (over 3 miles/4.82 kilometres from a city boundary).

Characteristics of water systems serving DUCs

In order to identify the characteristics of DUCs, we first gathered data on the spatial boundaries of formal and informal water systems that may be providing water to DUCs. Here, we relied on water system definitions from the federal Environmental Protection Agency (EPA) and California's State Water Boards.[4] Formal water systems are referred to as Community Water Systems (CWSs) which serve at least 15 connections for at least 25 year-round residents. CWSs can be owned and operated by cities, private for-profit companies, non-profit organisations, mutual/ratepayer – owned organisations, or special public districts. They can serve both cities and CDPs or other unincorporated areas, and their water quality is

[2] Because the US Census does not identify unincorporated developed areas that don't meet their criteria, it is likely that our analysis does not account for all of the non-DAC communities in the Valley. In contrast, based on our parcel-level methodology, we are confident that we have identified the vast majority of DUCs in the Valley.

[3] The 80% of state median household income is a standard drawn from the definition of a Disadvantaged Community, as found in the California Public Resources Code (PRC), Section 75005(g).

[4] These definitions are in Section 116275 of the *California Safe Drinking Water Act*, which is contained in Part 12, Chapter 4 of the California Health and Safety Code.

typically regulated by the state.[5] Once boundaries were identified, we joined CWS attribute data from the California State Water Resources Control Board (SWRCB) to these spatial boundaries. We then joined these boundaries to CWS attributes such as population served, primary water source type (groundwater vs. surface water), and ownership type (private vs. public) from the California Environmental Protection Agency SWRCB's Safe Drinking Water Information System (SDWIS) database (SWRCB 2016).

Private or domestic wells are owned by individuals and generally serve one household. They are not regulated by the state beyond the filling out of a well completion report and thus such household wells are considered 'informal'. We classify such State Small Water Systems (SSWSs) and Local Small Water Systems (LSWSs) as 'quasi-formal' because they are not regulated by the State of California, although in some cases counties do provide some oversight. We determined the location of 197 SSWSs in the San Joaquin Valley. We made the assumption that if a DUC is not served by a CWS or an SSWS, their residents must be served by either an LSWS or by domestic wells. Together, these four types of water provision arrangements form the Valley's water service meshwork, with water provision for DUCs being achieved through a continuum of formality from highly regulated CWSs to less-regulated SSWSs, to self-provisioning via unregulated LSWSs and domestic wells.

Table 1. Types of water systems serving Disadvantaged Unincorporated Communities

Disadvantaged Unincorporated Communities water provision type	Formality	Size	Water quality regulator
Community Water Systems	Formal	More than 15 service connections (SCs)	California Division of Drinking Water if more than 200 SCs and, in some counties, if less than 200 SCs
State Small Water Systems	Quasi-formal	5 to 15 SCs	County Public or Environmental Health Department
Local Small Water Systems	Quasi-formal	2 to 4 SCs	Regulated in some counties
Domestic wells	Informal	1 SC	Unregulated

Source: Author-compiled based on SWQCB 2020 and SWQCB 2017

Water quality calculation

The water quality of CWSs was characterised using data obtained from the SWRCB's *Human Right to Water Portal*, which categorises a CWS's compliance with the state and federal Safe Drinking Water Act (SDWA) standards (SWRCB, 2017). There are three possible forms of compliance status: 'in-compliance', 'returned-to-compliance', and 'out-of-compliance'. In-compliance means the system was not in violation of any SDWA standard at the time of the analysis (November 2017) and had maintained this status since the initial reporting date. We refer to this as safe drinking water throughout the study. Returned-to-compliance means that the system had one or more previous violations between 2012 and November 2017 that have since been resolved. We also consider this water to be safe at the time of the study but note that a system that has been out of compliance may be at risk of future violations. Finally, out-of-compliance means that the system had an active violation of one or more SDWA standards as of the data

[5] Water system boundaries are derived from OEHHA's CalEnviroScreen 3.0. The water system boundaries were originally collected through Tracking California, a partnership of the California Department of Public Health and the Public Health Institute.

download date (SWQCB 2017); we refer to this as unsafe drinking water. Because their water quality is under-regulated or not regulated, there is no consistent and regionally reported data readily available for SSWSs, nor for LSWSs and private domestic wells, which are the other ways households receive water in the Valley.

Determination of access to safe drinking water

Three variables were analysed to determine a DUC's access to safe drinking water. The first variable describes whether a DUC is served by a CWS based on its spatial intersection witha CWS boundary. If a DUC is intersected by a CWS, we use a second variable which determines the compliance status of the intersected CWS. If a DUC is intersected by a non-compliant CWS, we use a third variable which defines a DUC's proximity to a CWS that has in-compliance water, as measured by its distance to the nearest in-compliance or returned-to-compliance CWS. It should be noted that incorporation into a city does not mean that a DUC can obtain safe drinking water, as numerous cities and CWSs are out of compliance.

It is important to note our assumption about the relationship between the intersection of CWSs and DUCs, which is that if a DUC is fully or partially intersected by a CWS, then at least some of its residents are served by that CWS; we therefore use the term 'served' instead of 'intersected' throughout the study. Because we do not have parcel-level data on service, however, this is an estimate that may be over- or under-counted. Adding in parcel-level service data would be an important element of future research.

To determine a DUC's proximity to safe drinking water, we used an ArcGIS geoprocessing tool to calculate the distance from the edge of a DUC to the edge of an in-compliance or returned-to-compliance CWS. We then categorised the DUCs in terms of their proximity to an in-compliance CWS, identifying them to be either: within system boundaries, within 1 to 500 feet of system boundaries (0.3 to 152 metres), between 500 feet and 1 mile (152 metres to 1.6 kilometres) from system boundaries, between 1 and 3 miles (1.6 to 4.2 kilometres) from system boundaries, or more than 3 miles (4.2 kilometres) from system boundaries.

Qualitative data

We conducted 18 interviews over a 12-month period. Twelve of the interviews were intended to ground-truth the relationships between DUCs and the nearby CWSs and six were aimed at providing historical data about the development of DUCs in the Valley. Interviewees had expertise in multiple disciplines and areas including government regulation and administration, water system management and operation, academia, and non-profit technical assistance. Our co-authors – water justice advocates – contributed to the section on advocacy efforts that had been undertaken to increase DUC connections to formal water systems, and in doing to enhance access to safe drinking water. In order to further contextualise the inequities involved in the development of DUCs in the Valley, we also conducted archival research on city and county General Plans and Local Agency Formation Commission documents from the 1960s to the present.

FINDINGS: DUCS, INFORMALITY, AND INEQUITABLE ACCESS TO SAFE DRINKING WATER

The following sections describe the relationships between specific forms of informality in DUCs (particularly their morphology as meshworks of formal and informal elements) and inequities in access to safe drinking water. We describe the conditions of access to safe water in DUCs; these include the racial, spatial and class-based disparities associated with informality; the potential for formalisation; and the ways in which DUC residents and advocates are seeking water justice by addressing the problems of informality.

Informality is linked to a lack of access to Community Water Systems

Our spatial analysis indicates that DUC residents are served by a fragmented patchwork of small and underperforming water systems that result in uneven access to safe drinking water. The proliferation of varying forms of water service provision – as distinct from incorporated city services – results in situations where some DUCs have access to formal water systems (for example, piped water from CWSs) that are regulated by the state but do not supply safe drinking water. This often leads residents to shift to informal self-provisioning in order to secure water; for example, they resort to domestic wells, vended water, or informal hook-ups to a neighbour's wells or to piped water. Very often, however, these informal arrangements do not provide reliable or adequate access to safe water. This section looks at the issue of physical access to formal water systems as a whole; the following section examines access to safe drinking water.

Figure 1 summarises the results of our spatial analysis and illustrates the spatial pattern of service of DUCs by a CWS – either their own or that of a nearby jurisdiction. Map 1 shows dense clusters of DUCs that are not served by CWSs. These clusters of island and fringe communities surround the region's major cities along their southern borders and many remote and very remote communities are found in rural areas further away from cities. The spatial arrangement of these island and fringe DUCs can be partially explained by the northward growth patterns of the Valley's cities into areas inhabited by white and wealthier populations that bring water infrastructure investments with them (Dymski, 2006). At the same time, this spatial arrangement illustrates a pattern whereby communities inhabited by lower-income people and people of colour are often located through *de jure* and *de facto* segregation on the older industrial south and west sides of cities (Jimenez, 2017; Alvarado, 2020). In the rural areas of Tulare County and elsewhere in the Valley, there is also a vast number of remote and very remote DUCs that are not served by CWSs. Much of this disparity in access exists as a legacy of counties' racialised land use and general plan policies, which are intended to deprive 'non-viable' DUCs inhabited primarily by people of colour of drinking water and other infrastructure (Pannu, 2012; Balazs and Ray, 2014)

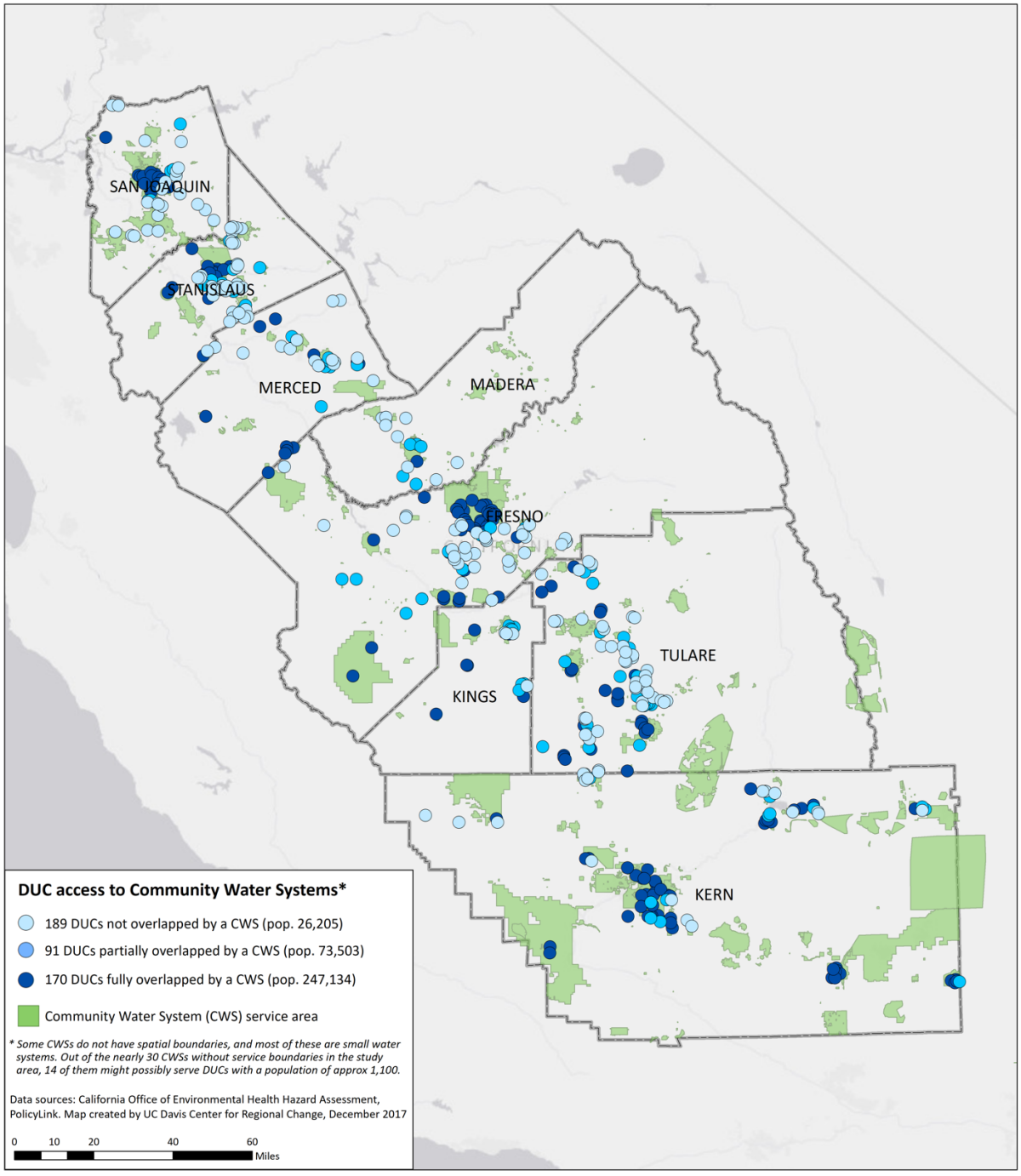
Of the Valley's 347,442 DUC residents, 247,134 (or 71%) live completely within a CWS service area boundary and can be assumed to be served by these CWSs.[6] Another 73,503 (20%) live in DUCs that are partially overlapped by a CWS, meaning that there is an unquantified number of people not served by that CWS.[7] A further 26,205 (8%) of residents are completely outside of a CWS boundary; we assume that most of these residents, if not all, rely on private domestic wells or LSWSs and lack access to regulated drinking water from a CWS. This estimate of well-dependent residents, however, is likely to be an underestimation due to the unregulated and informal (and therefore difficult to enumerate) status of these wells.[8] This analysis shows the uneven physical access to water from formal water systems (that is, CWSs) by DUC residents.

[6] We have made the assumption that location within a CWS is equivalent to being served by that CWS; this is an assumption that we had to make due to the lack of specific household-level service data and therefore it may overstate actual service.

[7] At the time of the study, there was no reliable source of data on actual water service areas with which to measure how many households within a CWS were served by that system. In order to address this data gap, we make the assumption that residents living within a CWS are served by that system; however, this may underestimate the number of households without service by a CWS.

[8] Using new methodology, a team from UC Berkeley (Pace et al., 2019) estimated that over 500,000 residents of the San Joaquin Valley (17%) may be reliant on domestic wells; however, unlike our analysis, it does not differentiate by income or incorporated status.

Figure 1. Disadvantaged Unincorporated Communities and access to Community Water Systems.



Source: Authors

Informality leads to unsafe drinking water in many DUCs

Residents of DUCs face significant challenges in access to safe drinking water. It is important to highlight that the high reliance on groundwater in the Valley is one reason that many households are exposed to unsafe drinking water. Of the 156 CWSs that serve DUCs in the Valley, 128 (83%) primarily rely on groundwater. These groundwater sources are often polluted with contaminants such as nitrates from agricultural fertilisers and cow manure run-off, pesticides, industrial chemicals such as 1,2,3-

Trichloropropane (TCP) and arsenic from geologic and industrial sources (Haugen et al., 2021; Lockhart et al., 2013).

DUC residents' problems with access to safe drinking water can be broken down into several categories: service by CWSs that are out of compliance; no CWS service (as described above); partial service by an in-compliance CWS; and service by a CWS with unknown water quality status. There are therefore several categories ofresidents who may be at risk of exposure to unsafe drinking water (Table 2).

Table 2. Compliance and level of service status for Community Water Systems (CWS) serving Disadvantaged Unincorporated Communities (DUC).

CWS service status and compliance	DUC population	
	Percentage	*Number*
Fully served by a compliant CWS	57%	197,898
Partially served by a compliant CWS	17%	59,426
Fully served by an out-of-compliance CWS	9%	30,201
Partially served by an out-of-compliance CWS	4%	13,398
Fully served by a CWS with unknown compliance	5%	19,035
Partially served by a CWS with unknown compliance	0%	679
Not served by a CWS	8%	26,805
Total	100%	347,442

Source: Author-compiled from State Water Quality Control Board 2017

We start with the full count of 347,442 DUC residents in the Valley; of these, approximately 197,898 (57%) are fully served by a compliant CWS. This leaves up to 149,544 (43%) of DUC residents who may not be served by safe drinking water, either because their CWS is out of compliance (affecting 30,321 or 9% of residents) or because – as with approximately 26,805 residents (8%) – they are not served by a CWS at all. There are also 92,538 (27%) of DUC residents who *may* also be exposed to unsafe drinking water. There are two sources of uncertainty in this overall figure. We know that 59,426 (17%) DUC residents are only partially served by an in-compliance CWS and 13,398 (4%) are partially served by an out of-compliance CWS. However, because we do not have access to household-level data, the exact number of residents who are not served by an in-compliance CWS or any CWS and are therefore likely dependent on private wells or other informal sources is unknown. There are also 19,035 (6%) DUC residents who are served by a CWS with an unknown SDWA compliance status.

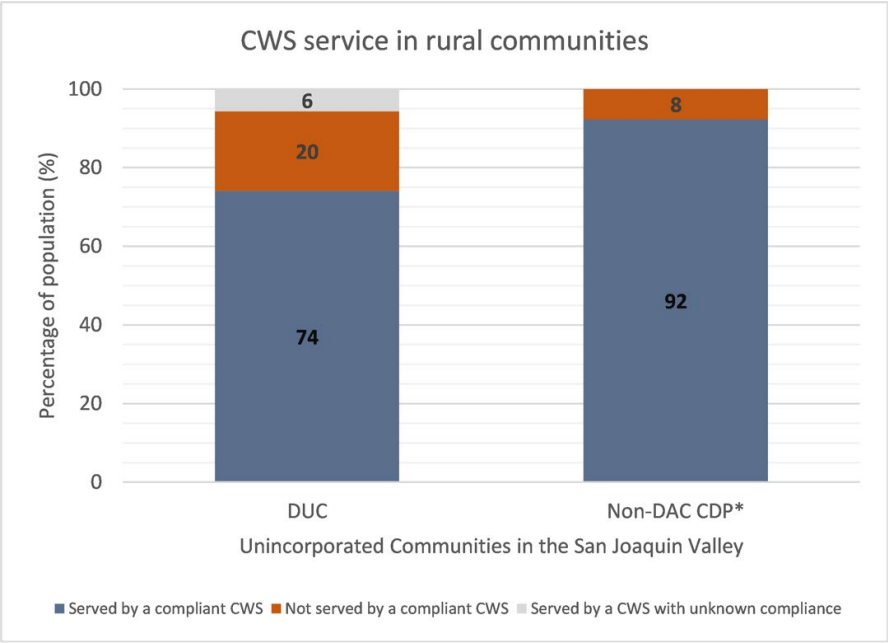
This analysis of access to safe drinking water within DUCs illustrates clear patterns of violation of the human right to water of area residents. In particular, we have shown that tens of thousands of DUC residents lack access to the safe and abundant drinking water that is necessary for their health and well-being.

Next, we compare DUCS to other types of Valley communities in order to highlight the spatial, racial and class dimensions of these human rights inequities.

There are spatial dimensions of informality linked to drinking water disparities

Using the community definitions in the Methods section, we compare DUCs to non-DAC CDPs, non-DAC cities, and DAC cities. Figure 2 compares the safety of water sources in DUCs and non-DAC CDPs. The category of 'Not served by a compliant CWS' includes both communities that are served by an out-of-compliance CWS and those that are not served by any CWS. As shown here, more DUC residents lack service from a compliant CWS (20%) than do non-DAC CDPs (8%).

Figure 2. Community Water Systems (CWSs) in Disadvantaged Unincorporated Cities (DACs) and non-DAC Census Designated Places (CDPs).

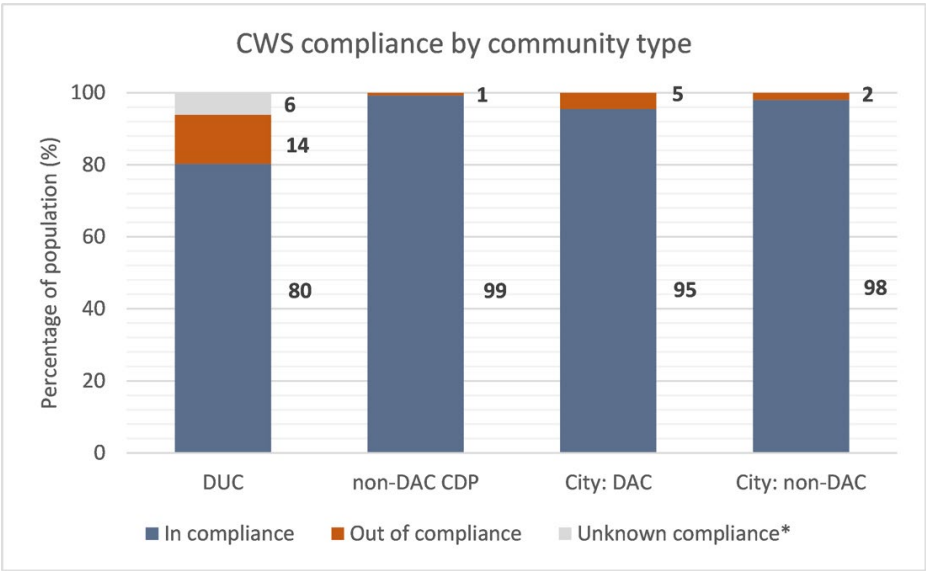


Source: California Office of Environmental Health Hazard Assessment 2018; California State Water Resources Control Board 2017; PolicyLink 2013; UC Davis Center for Regional Change

Note: DUC = Disadvantaged; Non-DAC CDP = Non-disadvantaged Community Designated Place

*Data value for percentage of 'Unknown compliance' is '0' for non-DAC CDP.

Figure 3. Community Water Service (CWS) compliance by community type.



*Data value for percentage of 'Unknown compliance' is '0' for non-DAC CDP, City: DAC, and City: non-DAC

Source: California Office of Environmental Health Hazard Assessment 2018; California State Water Resources Control Board 2017; PolicyLink 2013; UC Davis Center for Regional Change

Note: DUC = Disadvantaged Unincorporated Community; DAC = Disadvantaged Community; CDP = Census Designated Places.

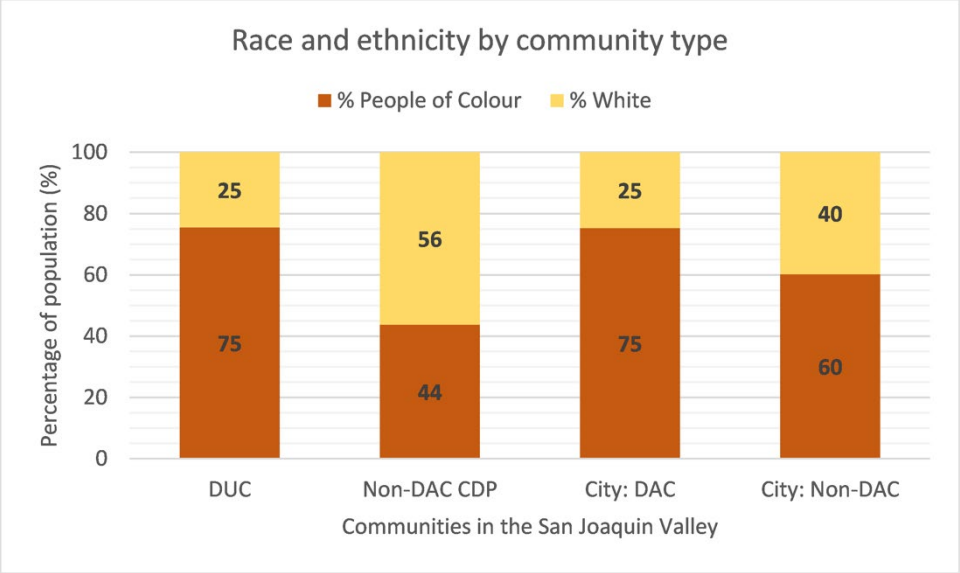
Next, we compare service from CWSs across the four community types. Unlike Figure 2 above, Figure 3 includes data only on communities that are served by a CWS; populations not served by a CWS (that is, who depend on domestic wells) are excluded.

Here we see that, of the four community types, DUCs fare the worst; 14% of their residents receive water from out-of-compliance CWSs, compared to 5% or less among the other community types. The fact that 99% of CWSs serving non-DAC CDPs are in-compliance illustrates the influence of income, even in unincorporated areas; that is, the higher-income (non-DAC) CDPs fare better than both non-DAC and DAC cities. While DAC cities fare worse than non-DAC cities (again indicating the salience of income), the variation is by only 3 percentage points. Overall, this figure shows that it is a combination of unincorporated status and low income which places DUC residents at the highest risk of all the community types.

There are racial and ethnic dimensions of informality linked to drinking water disparities

Our analysis shows racial and ethnic disparities in access to safe drinking water. First, there is an overall disparity in the location of people of colour in the Valley. As shown in Figure 4, while people of colour make up 67% of the population of the Valley, they are over-represented in DUCs where they account for 75% of the population; this compares to only 44% in non-DAC CDPs and 60% in non-DAC cities. People of colour in DAC cities make up the same percentage as those in DUCs, indicating a racial imbalance in both types of low-income communities. This imbalance can be understood as being rooted in similar historical land use and housing patterns. These patterns have led to racialised segregation and redlining that concentrates low-income people and people of colour in communities that have limited water systems and other infrastructure, and which also have other environmental hazards (Dymski, 2006; Pannu, 2012).

Figure 4. Race and ethnicity by community type.



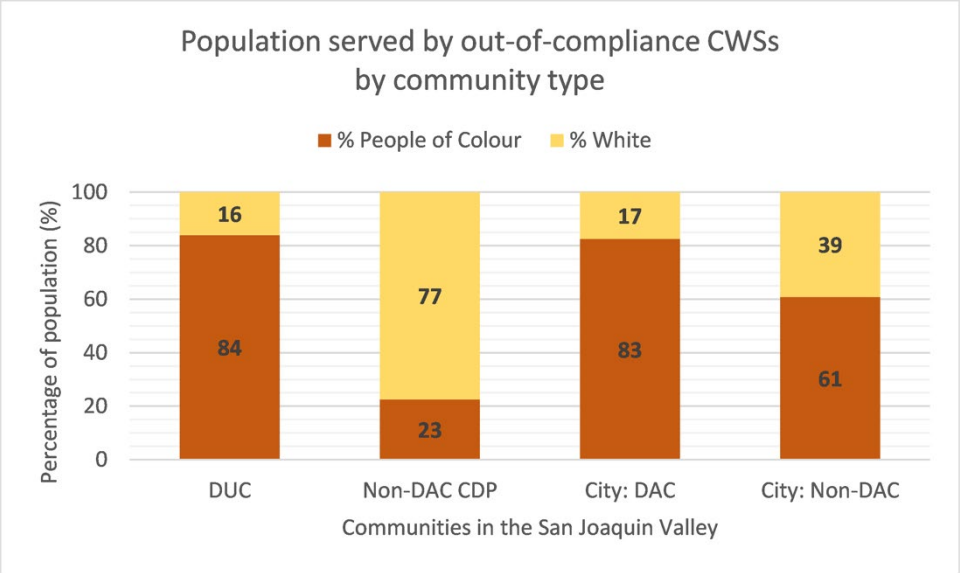
Source: American Community Survey 5-year 2018; PolicyLink 2013; UC Davis Center for Regional Change

Note: DUC = Disadvantaged Unincorporated Community; DAC = Disadvantaged Community; CDP = Census Designated Places

This segregated settlement pattern has implications for access to safe drinking water. First, people of colour in DUCs are much more likely than white DUC residents to lack access to water from a CWS (70% for people of colour vs. 30% for white people.) There is also a disparity with regard to race and ethnicity in

terms of water quality. Figure 5 illustrates service by out-of-compliance CWSs, by race/ethnicity, and by community type.

Figure 5. Percentage of residents served by out-of-compliance Community Water Systems.



Source: American Community Survey 5-year 2018, California Office of Environmental Health Hazard Assessment, California State Water Resources Control Board 2017; PolicyLink 2013; UC Davis Center for Regional Change

Note: CWS = Community Water System; DUC = Disadvantaged Unincorporated Community; DAC = Disadvantaged Community; CDP = Census Designated Places.

Here we see a complex pattern of access to safe drinking water that corresponds to the racial and ethnic composition of communities. In all but the non-DAC CDPs, people of colour are more likely than whites to be served by an out-of-compliance CWS. This contrast is particularly stark in DUCs and DAC cities, where people of colour are 84% and 83%, respectively, of those served by out-of-compliance CWSs. In both DUCs and DAC cities, these levels are roughly 10 percentage points higher than the overall representation of this group in the population. The similarity between DUC and DAC cities in terms of racial and ethnic disparity in access to safe drinking water shows the close relationship between race/ethnicity, income and safe water access regardless of informal status. Similarly, people of colour constitute only 23% of the residents of non-DAC CDPs who are served by out-of-compliance CWSs; this reflects the low percentage of people of colour that live in these relatively wealthier communities and the long history of racialised land use and housing in the region that created these demographic imbalances (Dymski, 2006).

One advocate from the Leadership Counsel for Justice and Accountability (LCJA) described the racial dimension of such inequities across the region in striking terms:

> The historic and systematic exclusion from municipal boundaries of neighbourhoods for communities of colour has meant exclusion from municipal services. As a continued pattern to build outward, rather than invest inward, continues, countless neighbourhoods – almost always neighbourhoods of colour – fall further behind with respect to public works investments (Personal communication, 2020).

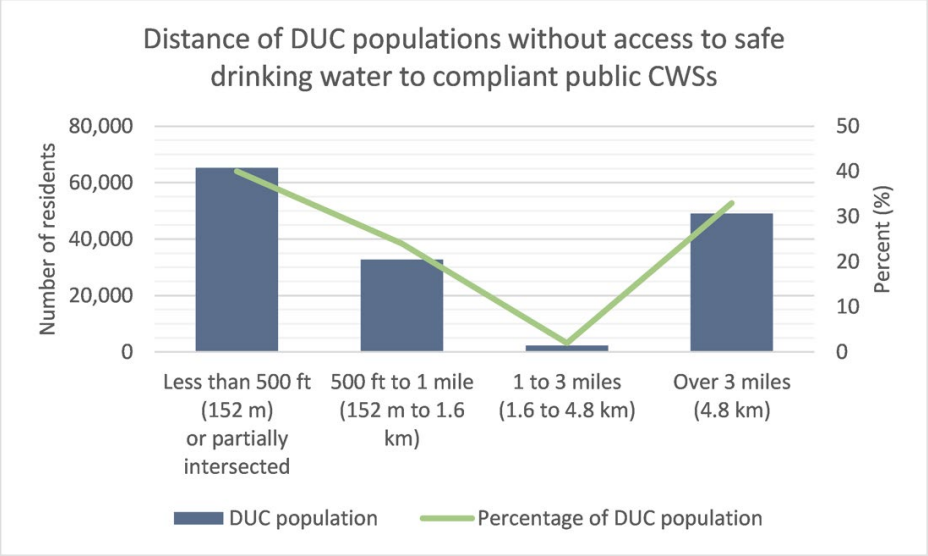
Formalisation is the focus of advocates' and public agencies' efforts to secure safe drinking water access for DUCs

Despite the dire circumstances faced by residents of DUCs, there are some prospects for improving conditions in these communities because many lie in close proximity to CWSs that can provide safe drinking water. Because of the ways in which informality reinforces and exacerbates disparity, community-based leadership and grassroots advocacy are working to formalise communities and their water provision in order to achieve safe drinking water in the San Joaquin Valley and beyond. This section will combine spatial and qualitative analyses to illustrate the potential to address the challenges of informality in safe drinking water access.

Physically close but politically far

Figure 6 presents the drinking water access of 149,544 DUC residents who may not be receiving safe drinking water. This includes residents in DUCs that are not served by a CWS, those only partially served by a compliant CWS, those served by an out-of-compliance CWS, and those served by a CWS of unknown compliance. It shows the distance to city-owned in-compliance CWSs as well as to CWSs owned by non-municipal special districts that are run by an elected board. This contrasts with privately owned CWSs that are owned by corporations or by mutual water companies, for example[9]. We use publicly owned CWSs as our measure because it is more likely that DUC residents will have a voice in key decisions about water rates, new infrastructure and future expansions of service when dealing with a democratically organised entity (Susskind, 2013; Weiner, 2018). This is important to note because different kinds of formal governance systems can have varied impacts on the ability of DUC residents to obtain the safe, abundant and affordable drinking water that is promised under the human right to water.

Figure 6. Count and proportion of Disadvantaged Unincorporated Community (DUC) residents without safe water, by distance, to publicly owned Community Water Systems (CWSs) delivering in-compliance drinking water.



Source: Source: American Community Survey 5-year 2018, California Office of Environmental Health Hazard Assessment, California State Water Resources Control Board 2017; PolicyLink 2013; UC Davis Center for Regional Change.

[9] Mutual water companies are any private corporation or association organized for the purposes of delivering water solely to its stockholders and members at cost.

For those DUC residents not served by a CWS or served by an out-of-compliance CWS, our analysis identified 65,344 residents (44%) residing within 500 feet (152 metres) of an in-compliance CWS, a further 32,768 residents (22%) living within one mile (1.6 kilometres) of an in-compliance CWS, and 2375 residents (1%) who live between 1 and 3 miles (1.6 to 4.8 kilometres) of an in-compliance CWS. This three-mile-distance threshold is important as it is generally considered to be the furthest practical distance for a water system service extension; therefore, for 66% of DUC residents, the distance between the DUCs and a publicly owned CWS is within a feasible distance for extension of service pipes or consolidation with larger and compliant water systems. That leaves 48,000 (33%) of DUC residents living three or more miles (4.8 kilometres) outside a CWS service area boundary. In their case, it may be possible to consolidate or regionalise several smaller systems in a shared managerial arrangement; this may be combined with the installation of new treatment plants and/or point-of-use filters for those continuing to use well water.

The spatial patterns of proximity of DUCs to safe drinking water is illustrated by the maps shown in Figure 7. These show large numbers of DUCs close to safe drinking water sources; there are many clusters of DUCs (symbolised by the darkest orange circles) that lack secure access to safe drinking water but lie in close proximity (within 500 ft or 152 metres) of an in-compliance CWS. These DUCs are generally located at the boundary of, and in fringe areas around, the region's major cities; there are also archipelagos of remote DUCs near smaller towns in the Valley'sagricultural areas.

Despite this positive finding about the proximity of many DUCs to potential safe water sources, there are disparities in the proximity of other DUCs. The 49,057 (33%) of DUC residents who live farther than three miles (4.8 kilometres) from a safe water supply face dire physical and economic conditions. Over three-quarters (76%) of these residents are people of colour. These very remote DUCs tend to be clustered on the west side of the Valley, in the rural hinterlands of Tulare County that are dominated by large-scale agriculture, and in areas of Kern County where there are both agriculture and petrochemical industries.

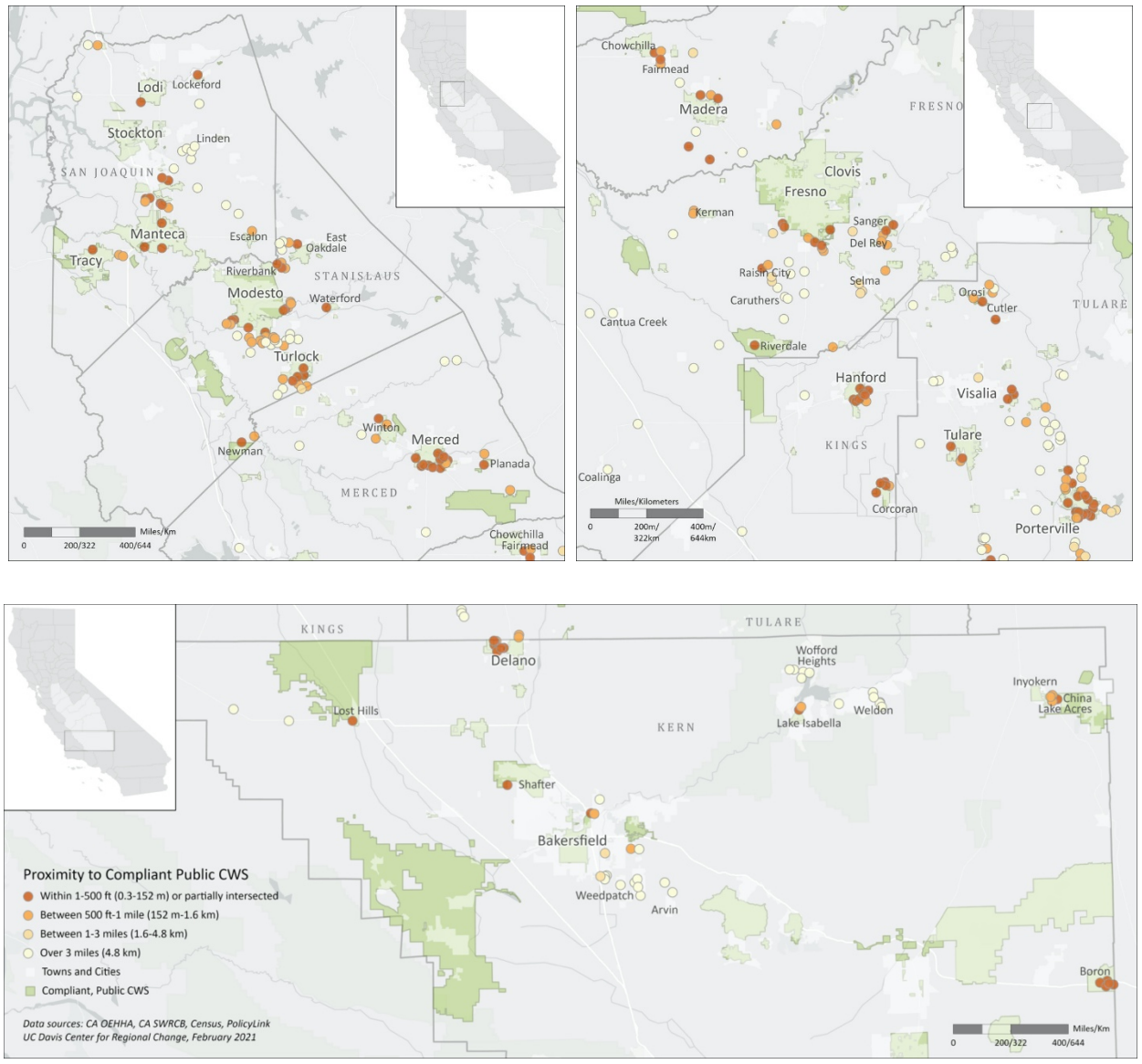
The close proximity of so many DUCs without safe drinking water to CWSs that could provide this water suggests that it is not physical distance alone that prevents service provision; rather, the barriers are caused by institutional disconnection and racial, ethnic and class discrimination (Pannu, 2012). Many cities explain their reluctance to annex DUCs into their service areas as based on cost. They are unwilling to take on existing water systems with antiquated technologies, as these water systems may need significant investment and possibly new infrastructure; they are also reluctant to take on formerly well-dependent ratepayers who have limited financial resources to connect to a CWS. This cost rationale is not without merit; however, when placed in the context of decades-long racialised exclusion of people of colour from cities and public services, and the availability of state funding for annexation, consolidation and service extension, it is hard to maintain that this exclusion is indeed solely based on financial considerations. The case of the Tooleville, a DUC in Tulare County, where the nearby city of Exeter has refused to annex and extend its municipal water service despite state offers financial support is a case in point (Balazs Ray, 2014; Rodriguez-Delgado, 2019).

Advocating for formalising of the water system meshwork

DUC residents and their advocate allies, in engaging in sophisticated negotiations to obtain access to safe drinking water, address problems of informality and the related racial and spatial dimensions of marginalisation. Underpinning many of the efforts we describe in the following section is California's Assembly Bill No. 685 (State of California 2012), which articulates the human right to water of the state's residents. Codification of this basic right has accelerated ambitious policy advances towards formalisation and aggressive investments to increase access to safe drinking water in the state. These efforts have resulted in both increasing formality through consolidation between CWSs (for those served by out of

compliance systems) and annexation and service extension to communities without formal water system access.

Figure 7. Proximity of Disadvantaged Unincorporated Communities (DUCs) to publicly owned and in-compliance Community Water Systems (CWSs).



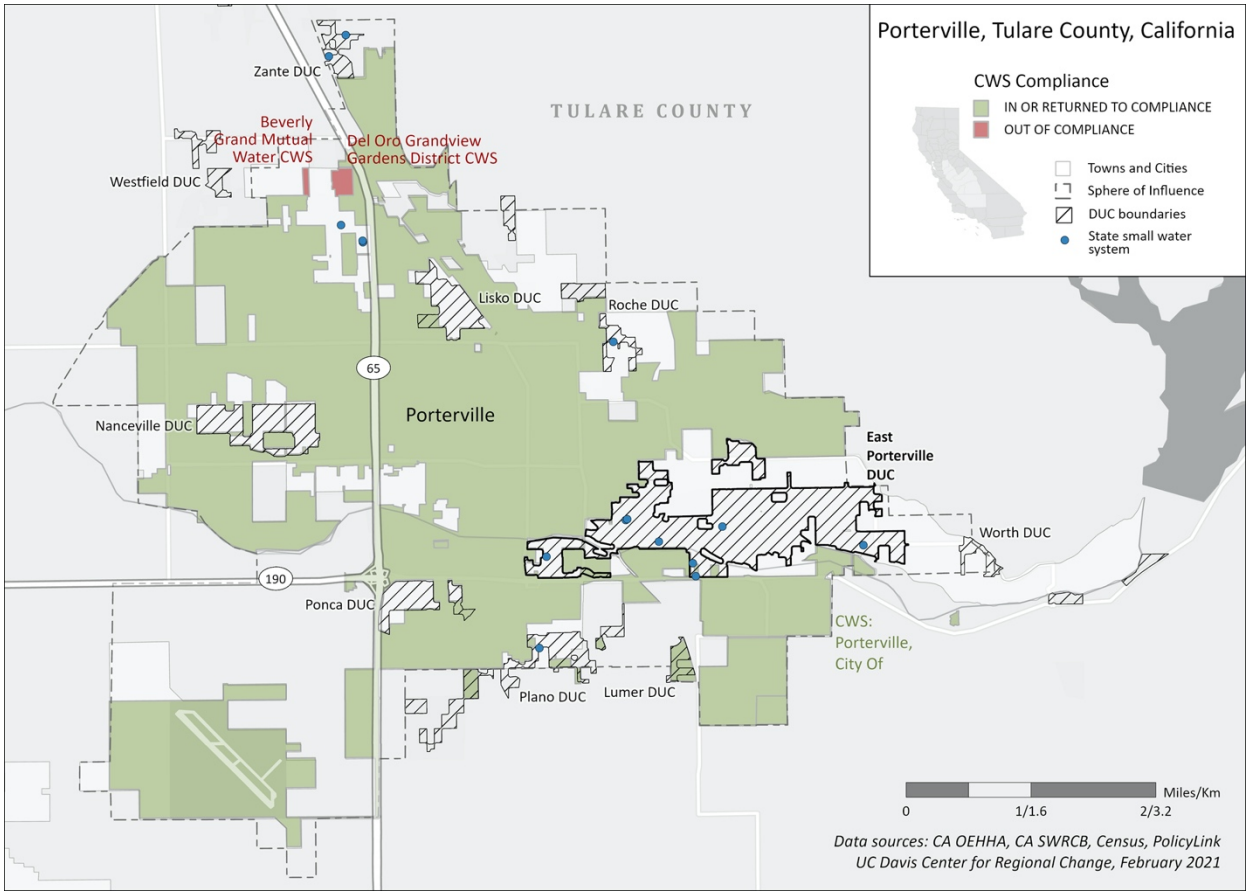
Source: Authors

New legal tools give the state water board power to intervene when local efforts fail. Senate Bill 88 and subsequent bills added language to the California Health and Safety Code in the form of the Mandatory Consolidation or Extension of Service for Disadvantaged Communities; the state can require a CWS to extend its services to, or consolidate with, a nearby community that does not have access to safe drinking water.

The case of East Porterville, an unincorporated community adjacent to the City of Porterville in Tulare County, is an example of a DUC that received formal water service via municipal service extension with optional annexation. East Porterville's predominantly low-income Latino population (79% of the 7300

residents compared to 66% Latino in Porterville) rely on shallow private wells fed by the nearby Tule River that has a history of running dry during droughts, in addition to water quality problems like nitrate contamination. The 2012-2016 long-term drought caused hundreds of East Porterville's domestic wells to run dry (Tulare County, 2017; Personal Communication, 2017; Gailey et al., 2019). To confront this crisis, local organisations such as Self-Help Enterprises, Community Water Center and the Porterville Area Coordinating Council lobbied the state to facilitate extending the City of Porterville's water service to households in East Porterville. The city eventually agreed and secured US$48 million in state financing. It now delivers safe drinking water to more than 750 households in East Porterville via three new municipal wells (DWR 2018; Castillo 2018). To be included in the project, residents had to sign an extra-territorial service agreement, which meant that eventually they agreed to be annexed by the City and therefore be included in a formal governance and water provision system (Castillo, 2016). See Figure 8 for a map of the Porterville area.

Figure 8: East Porterville and other DUCs in the City of Porterville area.



Source: Authors

The success of the East Porterville Water Supply project demonstrates that incorporated cities can extend their municipal services and city boundaries to DUCs to address water access problems, especially when pressured by state and social movement actors (and, in this case, under condition exacerbated by a drought emergency). It also shows how one DUC achieved material formalisation and will eventually be politically formalised (incorporated as part of the City of Porterville). Advocacy efforts have since led to statutory changes in which cities that propose to expand their boundaries must annex DUCs that border the annexation area if members of that community want to become part of the city.

Formalisation through annexation and consolidation are resource-intensive efforts and must rely on state funding; the unreliability and fluctuations of such funding has put DUCs at risk. Fortunately, however, this has begun to change. In 2019, with Senate Bill 200, California established the Safe and Affordable Drinking Water Fund (SADWF) to facilitate and sustain formalisation processes; it provides US$130 million per year for 10 years to develop water infrastructure in disadvantaged communities. The State Water Board's Safe and Affordable Funding for Equity and Resilience Program (SAFER) aggregates the "set of tools, funding sources, and regulatory authorities" that supports efforts to achieve the human right to water (SWQCB 2020). In addition to the SADWF, capital improvement funds have been instrumental in increasing access to necessary drinking water infrastructure; historically, these have left a critical gap in the funding to support ongoing operations and maintenance, a gap which SAFER seeks to fill. Other policy tools advanced by advocates remediate past exclusion by requiring cities to provide water and wastewater services to DUCs with inadequate services. In addition to connections between existing systems, for communities that may depend on domestic wells or SSWSs that do not reliably provide safe drinking water, service extension and/or incorporation of a DUC into the service area of a particular CWS is pursued.

DISCUSSION AND CONCLUSION

In the findings above, we demonstrate how DUC residents suffer from a lack of adequate access to safe drinking water; we also show how these conditions are closely associated with informality coupled with racial, ethnic and class disparities. At the same time, there is a pattern of spatial proximity between many DUCs and compliant CWSs, a proximity which opens up opportunities for safe drinking water access through formalisation of the water system meshwork. In responding to this opportunity, water justice advocacy efforts have focused on formalisation strategies.

This analysis has framed disparities in water access in DUCs as a special case of violationsof the human right to water. This violation is both distributional and procedural, which are two key dimensions of environmental, and thus water, justice (Schlosberg, 2013). We have argued that informality is a significant – but not the only – factor creating these conditions of disadvantage. The crucial elements of this framework focus on the role of informality in the broader positioning of marginality that is based on space, race, ethnicity and class; the framework also focuses on the particular relationships – the meshwork – among the formal and informal elements of the water provision system. The concept of the meshwork is important in framing informality and formality not as binary conditions, but rather as interwoven in specific ways in different places. Thus, DUCs illustrate a particular kind of meshwork defined by their low-income status (disadvantaged) and lack of formalised municipal governance (unincorporated), but where some residents have access to formal water sources (CWSs) and others do not. Likewise, even when a DUC has access to a formal CWS, the CWS is often not reliably supplying safe drinking water. We have argued that while the specific configuration of informality varies by community, informality nearly always results in problems for the well-being of DUC residents.

We have identified a continuum of informality linked to problems of access to safe drinking water. At one end of the continuum – with the best conditions – are the residents of DUCs that are fully served by an in-compliance and highly state-regulated CWS; a less-ideal situation is a locally regulated SSWS; less ideal still is the situation of those who are only partially served by such a system; even more unfortunate than that group are those with an out-of-compliance CWS or SSWS (which could be repaired or could be consolidated with a nearby SDWA-compliant CWS); least fortunate of all are those not served by any CWS and who thus must self-supply from mostly unregulated LSWSs or – worse – from domestic wells. This formality continuum addresses both the conditions of water access and the political and economic means to achieve safe water access.

A community's location on this continuum structures the distribution of environmental risks and benefits. As shown above, on one end of the continuum we found upwards to 150,000 DUCs that may

lack adequate access to safe drinking water. Those not served by a CWS are likely to be reliant on domestic wells drawing from polluted groundwater, while others are served by out-of-compliance CWSs. Even those DUC residents at the other end of the continuum who are served by a currently in-compliance CWS may be at risk in the future because these often are burdened by aging infrastructure, limited technical and managerial expertise, and a poor capacity for obtaining outside investments. All these scenarios may cause residents to oscillate between formal and informal water provision strategies; when they lose access to adequate quantity and quality of drinking water from a formal source, they may shift to informal self-provisioning with bottled and vended water, or the use of water from domestic wells.

DUCs, as informal settlements positioned physically and politically outside of incorporated places and therefore are often marginalized in the processes and infrastructure needed to access safe drinking water. While in theory DUCs are represented and served by county governments, this relationship has historically been fraught and has resulted in limited public services and political voice due to systemic racism and class-based discrimination (Pannu, 2012). Furthermore, counties must serve dozens of DUCs, often with limited human and financial resources themselves; this is especially important given that DUCs tend to have few if any paid staff allocated to drinking water oversight even in their formal CWSs. Many DUC residents suffer violations of their human right to water because of the limited public regulation of SSWSs and LSWSs and the lack of regulation of domestic wells.

The intertwined roles of race, ethnicity and income are manifested in the disparities in safe drinking water access experienced by low-income people and people of colour within DUCs (Pannu, 2012, Balazs and Ray, 2014). The broader factors of structural racism have been highlighted in analyses of the historical origins of DUCs which identify them as being the product of urban segregation and redlining, and as embodying the legacies of racialised agricultural and petrochemical industry labour systems (Dymski, 2006; Pannu, 2012; Eissinger, 2015; Alvarado 2020,).

The paper maps the contours of water injustice through a comparison among four types of communities: DUCs, non-DAC CDPs, DAC cities, and non-DAC cities. This four-way comparison has shown the complex relationship between informality, race, ethnicity and class. In particular, the comparison between DUCs and non-DAC CDPs has demonstrated the ways in which race, ethnicity and class in some cases exceed the influence of informality. In the case of non-DAC CDPs, their informal status is sometimes compensated by the higher income levels of their residents and by greater concentrations of white people (arguably with higher degrees of social and political capital to advocate for government assistance). In these non-DAC CDPs, many residents have relatively high levels of access to safe and abundant drinking water; on the other hand, the influence of race and class is indicated by the ways in which concentrations of low-income people and people of colour in both DUCs and DAC cities mirror their low levels of safe drinking water access compared to non-DAC CDPs and non-DAC cities. Nonetheless, the fact that DUCs are more likely than all other community types to be served by out-of-compliance CWSs shows the relevance of their distinctive informal status and the combined working of their racial and ethnic composition.

We have also shown that there are possible solutions to the problems of informality in water access; these are evidenced by the close proximity of the majority of DUC residents to sources of safe drinking water in nearby CWSs. Specifically, we have shown that two-thirds of DUC residents without safe water access live within one mile (1.6 kilometres) of a source of such water systems. This contradicts the rhetoric of those cities, counties or water districts who are opposed to investing in DUCs on the grounds that their far-flung rural and remote placement makes such investments financially unfeasible. Community advocacy and new state legislation are needed to overcome the legacy of racialised discrimination against these informal communities. Community organising and policy advocacy have begun to address the challenges of informality in an effort to shift DUCs from their marginalised status and thus transform their conditions.

This study is the first to examine the status of DUCs relative to drinking water access and quality in California; it thus has the potential to guide future studies and offers a foundation on which to build. It adds value to earlier scholarship about incorporated DACs (Balazs et al., 2011; Balazs and Ray, 2014) by highlighting the additional layer of risk to the human right to water that informality places on communities. It particularly highlights how a lack of municipal governance limits the political and economic capacities of DUCs more than it does that of other types of communities.

Given that it is the first study of its kind, it also important to point out some of its methodological limitations. Because of the small size of most DUCs relative to their surrounding Census Block groups and Census Places (our demographic enumeration levels), it is hard to accurately measure many key indicators such as income, national origin and education levels. Small sample sizes can lead to high margins of error in many measurements. Limited regulation and mapping of domestic wells, LSWSs and SSWSs make it difficult to make accurate counts of these key water infrastructure elements, although several on-going studies will help address this problem in the future (see, for example, Pace et al., 2019). The lack of detailed water service line data makes it difficult to count the specific populations served by many CWSs; this can lead to an unquantified number of DUC residents who are partially served by an SSWS or CWS. Finally, because descriptions of compliance status are based on a single analysis at one point in time, the data should not be taken as a definitive statement of drinking water quality over time.

Future research could address these limitations by following several trajectories. Comparative studies of DUCs in the San Joaquin Valley and other regions of the state and country (for example, *colonias* on the US-Mexico border, in Indian Country, and in the Black Belt of the Southeast) could illuminate the broader principles underpinning the relationship between informality and water justice. To provide finer-grained data than that available from the census, household income and demographic surveys would be better to illustrate a wider array of characteristics particular to DUCs. Likewise, mapping actual water lines – instead of the boundary of CWS service areas – would more accurately identify the households served or not served by a CWS or SSWS. Adding a comprehensive layer of data on the presence of domestic wells would also provide for a more complete picture of water access than does the current study and would test our assumptions about communities that are known to be outside of CWS service areas. Following on this study's finding about the poor water quality in the region's DAC cities, new research on the urban dimensions of water access would also be valuable. Finally, future studies can examine the impacts of policy initiatives such as California's Safe and Affordable Drinking Water Fund and the Sustainable Groundwater Management Act in order to assess changes in water access and quality in DUCs and other disadvantaged communities. In combination with this article, such a research agenda can provide important insights into the origins and fate of the water justice struggles of DUCs in California and throughout high-income countries.

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