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School of Geography and the Environment
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Where Will the Water Come From? Verifying the Urban Water Crisis Through Drought Issue Framing

Erin Rugland
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Abstract

Three prominent narratives exist within urban drought literature: that there is a global impending urban water crisis; that water will be reallocated from rural to urban uses; and that water scarcity is a socially constructed, rather than natural, problem. Many of these claims arise from studies which do not use primary data from cities at scale. In response, this study uses qualitative content analysis to investigate urban drought issue framing within 123 city planning documents in 30 cities globally. Results indicate that cities are acutely aware of climate impacts on the extent and frequency of drought in their bounds, yet that global models are insufficient for local needs. Cities also have more holistic conceptions of drought and water scarcity than presented within global models. Additionally, rural-urban water transfers are not planned in this cohort of cities, and urban areas support agriculture during drought in ways that blur the idea of urban-rural competition. Finally, the connection between problem definition and solution is found to be nonlinear within urban drought planning, but that several inputs—including formal drought definitions—have little bearing on resultant drought mitigation strategies. Overall, this study reveals the wide gap between research and practice in regard to drought management, and implores researchers and organisations alike to engage with primary data from cities.

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I am grateful to have had the Master of Philosophy experience, wherein I could pursue this project whilst taking the time to digest both the taught components of my degree and the personal motivations of this topic which continue to haunt me. Water being a very applied subject, it is true that my personal experience with drought management is fraught, and I continue to have a lot of questions about how we pursue it. Whilst the narrative of this dissertation dissuades dire predictions about cities running out of water, I still might not be fully convinced that we—as an entire populace—really know how to handle drought. And yet Day Zeros are always narrowly avoided.

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1 Introduction

Urban water scarcity is deemed a 'creeping crisis,' caused by a limited supply that is dwindling due to increasing urban demand and reduced water renewal due to climate change (Kallis & Coccossis, 2002). According to the UN Convention to Combat Desertification's (UNCCD) *Global Drought Snapshot*, few hazards claim more lives, cause greater economic losses, or affect more sectors of society than drought (Tsegai et al., 2023). The UNCCD emphasizes that droughts often unfold whilst escaping public and political attention. The report warns of climate-change-induced famine in several countries, global surges in forced migration, water conflicts, and rapid ecosystem erosion. Drought is often conceived as a rural problem due to a focus on agricultural losses and land degradation (Savelli et al., 2022); however, drought impacts urban systems as well (Singh et al., 2021). Spurred by climate change, increased urban droughts may put further pressure on rural and agricultural water supplies such that cities will siphon them away to satisfy their own demands (Garrick et al., 2019). Urban water suppliers often have more political and financial influence than their rural counterparts, and thus more ability to control or take water in a larger, regional 'hydraulic reach' that affects rural areas (Cantor, 2021; Scott & Pablos, 2011).

Crucially, however, many of the global studies raising the warning signal about the urban sector's water-scarce future rarely engage with the water-related plans and policies of cities themselves. Instead, there is an over-reliance on surface water availability projections which cast a dire future, but are not necessarily translatable into local contexts (Greve et al., 2018; J. W. Hall & Leng, 2019; Zhang et al., 2019). A growing body of literature calls into question the utility of global claims without further evidence and inputs from localities (Biswas & Tortajada, 2010; Linton & Saadé, 2024; Puy & Lankford, 2024). Similarly, several scholars argue that especially in centralised contexts like cities, issues of water scarcity have more to do with the allocation of water in society and across sectors than drought itself (Aguilera-Klink et al., 2000; Bruns & Frick-Trzebitzky, 2014; Huff & Mehta, 2019). These scholars contend that cases of insufficient water supplies arise primarily from management decisions, with drought causing additional pressure to poorly allocated systems (Kallis, 2010; Mehta, 2003; Muller, 2018). Discourse about water scarcity, the impending doom of cities running out of water, or indeed even the so-called 'water wars' of the future serve to foment competition amongst water sectors (Celio et al., 2010), justify expensive and unneeded water supply projects (Loftus & March, 2019), and incite speculative private investment in water markets (Runyon & Sackett, 2021).

As such, urban drought preparedness warrants further attention, particularly from a perspective grounded in urban planning, to verify these speculations. Drought planning is often considered reactive rather than proactive, relying on emergency management rather than investigating ways to reduce drought risk and vulnerability (Stolte et al., 2023). However, due to drought's long onset time and slowly unfolding impacts, some scholars claim that understanding drought preparedness and mitigation may be an insightful way to predict performance in broader matters of climate change mitigation and adaptation (Gutiérrez et al., 2014).

A critical component to further understand the major narratives about urban drought—the impending global urban drought crisis, the redistribution of rural supplies to urban supplies, and the idea of scarcity as a result of management practices—is understanding the construction of the problem and how this construction may or may not lead to limited solutions at the urban scale (Cravens et al., 2021; Müller & Kruse, 2021; Sullivan et al., 2024). The goal of this analysis is to verify narratives about urban drought using primary data from cities themselves, to reveal how they understand the problem and whether this understanding is in line with generalized talking points about the matter. Frame analysis is critical to understanding policy- and decision-making processes across the fields of public policy, communications, and political science (Goffman, 1974; Rein, 1983; van Hulst & Yanow, 2016). This study uses qualitative content analysis for multiple plans (i.e., a city's network of plans) in 30 cities to investigate how framing influences urban drought management in relation to these three pertinent narratives about urban water scarcity (Figure 1) through the following research questions:

- RQ1. How are urban drought risks framed and justified by cities?
- RQ2. Do issues of urban-rural water allocation emerge in urban planning processes?
- RQ3. Does the framing of drought impact chosen drought management strategies?
- RQ4. Does the framing of drought impact the distribution of drought management strategies among users?

Figure 1. Nesting the research questions within the major urban drought narratives.

The rest of this introduction situates predicted increases in drought prevalence and severity with respect to the role of cities in adapting to climate change. The literature review traces the three urban drought narratives to reveal some of the gaps in understanding that this analysis helps to fill. These gaps are addressed through the theoretical framework of *issue framing*. This paper applies qualitative content analysis to city plans to discover from primary sources how cities are conceptualizing issues of urban drought and water scarcity, as well as to see how these framings may connect to the proposed drought management solutions.

1.1 Background

This study engages in concepts about urban climate change adaptation and associated networks and is situated within broader literature about drought. Generally, cities have become the scale at which climate change adaptation is primarily attempted. Global networks facilitate this—and even set the norms for this—which are used as the cohort of study in this analysis. However, despite the threat of climate change, drought seems to be an under-developed climate adaptation area. The following subsections further elucidate these overlapping contexts.

1.1.1 Cities as Climate Adapters

Cities are particularly vulnerable to the impacts of climate change due to their population and infrastructure densities. Some accounts attribute the largest contributions of greenhouse gas emissions to cities, although this is also contested, as the city as a *system* can be understood to have high consumption and emissions but at *scale* results in lower emissions per person than rural areas (Bulkeley, 2010; Reckien et al., 2014). Cities and municipalities are seen as an ideal scale for climate change mitigation and adaptation, and in many contexts are more proactive at climate adaptation than national governments (Bulkeley, 2010; Khalid & Okitasari, 2023). Many cities have taken the mantle of climate governance, to the extent that municipalities, and the sustainability experiments therein, have become leaders in modern global environmental politics (Acuto, 2013). Urban planning with a resilience lens is often the key instrument to initiate municipal climate adaptation (Braun, 2014; Taylor et al., 2021; Zweig, 2017). Climate resilience focuses on a city's ability to 'bounce back' after shock events or disasters (Laeni et al., 2019; Meerow & Stults, 2016). Understandably, climate adaptation plans often focus on carbon reduction and clean energy systems, while resilience plans often focus on preparing for disastrous events, like storms or flooding. Both climate adaptation and resilience have been fomented in part by transnational municipal networks (TMNs).

1.1.2 Planning for Urban Resilience with Transnational Municipal Networks

Studies which try to measure climate change adaptation progress in cities consider planning to be the beginning of direct or implementable action (Heidrich et al., 2013). Many studies count the activity of plan-making as evidence of action toward climate adaptation (Araos et al., 2016; Lee & Painter, 2015). This is often facilitated by TMNs like C40 Cities (C40) or the Resilient Cities Network (RCN)—international nongovernmental organizations that enable lesson-sharing among participant cities and fundraise for and disperse resources for them. Networks of cities and TMNs are a common scale for climate adaptation research (Aylett, 2015; Meerow & Neuner, 2021). Membership within TMNs correlates with increased climate adaptation activity and overtakes national politics in influencing local action (dos Santos & Puppim de Oliveira, 2024; Heikkinen et al., 2020; Lee & Koski, 2014). TMNs foster climate action by unlocking access to pools of private funding, tools (such as green building manuals), and knowledge (such as peer-learning from other network members, through network-provided forums) (Bulkeley, 2010). The function of TMNs in shaping the norms of global environmental politics and in influencing modern urban management cannot be overstated (Acuto & Ghojeh, 2019; Lee, 2019). One phenomenon of TMNs is their ability to "govern from the middle," wherein the norms, standards, and policies they promote influence not only city management and investment decisions, but in turn, create some standardisation which is easier for industry to navigate and benefit from (Román, 2010, p.73). For example, the C40 Cities' *Green Building Retrofit Manual* lessens the burden for cities interested in adopting a green building retrofit programme and broadens the market for commercial actors, too (ibid.). TMNs are subject to criticisms which relate to this, such as the spread of neoliberal approaches to city governance. Long and Rice (2019) suggest that the current neoliberal paradigm of many cities—specifically proliferating the privatization of services—might present issues of inequality and injustice, which may be magnified by the promotion of certain strategies by TMNs. However, TMNs often also champion goals that are more ambitious than international climate agreements and act to reinforce these agreements, such as through the C40 Cities initiative to create municipal climate adaptation plans that are in line with the goals of the Paris Agreement (Bulkeley, 2010). TMNs help cities engage in dialogues and processes that they may not have otherwise undertaken and would certainly not have undertaken in the same form. For example, participation in C40 helped South East Asian cities to undertake stakeholder engagement processes, which is not otherwise a norm of planning in the region (Kamiński, 2023). A global platform for sharing progress can be an incentive for both network participation and for making progress on climate adaptation or mitigation goals (Huck et al., 2020).

TMNs do not lead to a homogenized approach; rather, due to their unenforceability and different interpretations of problems and successes by members, cities maintain a wide variety of approaches to climate adaptation despite their participation in C40 or RCN. In other words, learning is uneven and TMNs are weak in their ability to influence cities, as cities tend to adopt incremental, status quo changes (Davidson & Gleeson, 2015; Heikkinen et al., 2019; Khmara & Kronenberg, 2023). Further, there is a hierarchy within these networks wherein some cities—the

New Yorks and Londons—act as outsized hubs and set norms in the network, due to their geopolitical influence and perceived status as innovative climate leaders (Lee, 2019; Lee & van de Meene, 2012; Lohmeyer et al., 2023). Cities in the Global North tend to have more power in these networks than those in the Global South, as they have an outsized influence on norms and their approaches are more quickly considered best practices (Bouteligier, 2013; Kamiński, 2023).

Whilst these networks and their participants are sophisticated in their approaches to carbon accounting, increasing energy efficiency, and curbing emissions production, they are less adept at other forms of climate mitigation and adaptation (Dumała et al., 2021). Aylett (2015) find in their study of urban climate adaptation that actions tend to be very siloed within municipal governments. Notably, water-focused departments are at the margins of these actions (Dong et al., 2020). Interestingly, the barriers that participating cities identified to climate action include a lack of local jurisdiction to act; meanwhile, one thing that tends to be exceptional about water agencies is their jurisdictional reach into the watershed, oftentimes beyond city boundaries (Scott & Pablos, 2011). Aylett (2015) reinforce the idea that effective climate action is institutionalized across city departments, and that water agencies are particularly important to strengthen a city's institutional position to act and adapt. However, although water generally receives marginal attention, there is also a hierarchy of which water issues receive more adaptation attention. For example, in 2016, drought-related tools only represented about 10% of resources available to support local climate change adaptation—just half that of what was available for flooding (Nordgren et al., 2016).

1.1.3 Drought Threat from Climate Change

Drought is a recognized natural hazard and an effect of worsening climate change. Potential planetary drivers of drought vary and are difficult to predict: increased land and sea surface temperatures; surface-atmosphere interactions which produce hot, dry air; anomalies among these feedback loops; and atmospheric temperature variations all contribute to drought conditions (Lin et al., 2022). Drought is the hazard that affects the most people globally and multiple international agencies project worsening drought severity and duration due to climate change (Rossi & Cancelliere, 2013; Van Loon & Van Lanen, 2013; Wilhite, 2016). Drought has outsized impacts on developing countries, which experience more mortalities and bigger proportional impacts to economic output (Verbist et al., 2016). Drought-induced famine is also more likely to occur in developing regions.

Disaster can be defined as the confluence of hazard and vulnerability, and risk adds probability into this equation (Vasilescu et al., 2008). Drought is unique from other hydrological disasters like flooding, because its slow onset and long duration disperse hazard and risk over time, and vulnerability is difficult to determine until impacts occur. Some consider drought to be a socio-natural hazard because its causes can be either natural or human-induced (Lange & Cook, 2015; Vasilescu et al., 2008). Indeed, due in part to varying definitions and indicators of drought, it is hard to measure and declare the boundaries (start and end) to a drought event (Mishra & Singh, 2010; Panu & Sharma, 2002; Van Loon, 2015). These factors impact understanding of, scholarship about, and management tactics for drought.

Other natural hazards like heat waves can exacerbate the impacts of drought. In turn, drought can exacerbate other hazards such as wildfire risk, flooding, landslides, and subsidence (Alves et al., 2023). The acute ecological impacts of drought are diverse and affect ecosystems of all types through reduced water supply, deteriorated water quality, reduced air quality, decreased vegetative cover, increased soil exposure and erosion, and disturbed riparian habitats (Mishra & Singh, 2010). The socio-economic impacts range from decreased agricultural output, reduced energy production, negative impacts to the recreation sector, and individual mental distress and decreased physical health (Fleming-Muñoz et al., 2023). Negative economic impacts, including lower rates of employment, are felt in urban and rural areas alike (Desbureaux & Rodella, 2019). In more informal settings, drought impacts, and particularly higher water prices, can result in increased dependence on bottled water, informal water vendors, or hauled water tankers (McEvoy, 2015).

Cape Town made headlines during its ‘Day Zero’ drought events of 2017/2018—but there has otherwise been little research into urban areas’ ability to cope with drought on a wide scale that is grounded in primary data from cities themselves (Buurman et al., 2017). Nonetheless, drought is a threat to urban areas due to the multiplying factors of population increases, climate change, and extreme heat (Dilling et al., 2019). A concern in the literature is the ability of cities to cope with peak water demands during uncharacteristically hot and dry summers, leading to temporary lapses in urban water availability from short-term drought events (Finley & Basu, 2020). This reflects the nuanced nature of water supply deficits in cities, as conditions of water scarcity can be spurred by a multitude of factors. Having provided the context for urban drought—its anticipated increasing effects and the context in which cities are preparing—these nuances are described further in the following literature review.

2 Literature Review

A thematic literature review was conducted to gain a holistic understanding of urban drought risk and response, through studies conducted at several scales of analysis: from global to local. The parameters of the review included key word search through Search Oxford Libraries Online (SOLO) of the terms "urban drought," "urban drought risk," and "urban drought preparedness," with an open timeline of study publication date, though the oldest relevant article is from 1980. Cross-referencing, or a snowballing literature review, was also employed, wherein the reference sections of each article were searched to identify further relevant literature. These search methods resulted in a review of 161 articles.

These terms revealed several themes about urban drought. First is the difficulty in defining drought, a well-developed area of literature which postulates that how drought is defined affects what solutions are viewed as viable, comprising section 2.1. Further, there is debate about the utility of some proposed drought definitions and whether they account for "drought," an environmental phenomenon, or "water scarcity," an imbalance between water supply and demand which may be human-caused, and the increasing difficulty of parsing out the difference between these in the age of the Anthropocene. Thus, water scarcity emerges as a theme in section 2.2 and acts as a critical counterargument to narratives of an inevitable, emerging global water crisis. The literature on water scarcity develops the idea that issues of water availability are due to human actions and political choices about the allocation of water across society, and that scarcity is used as a discursive tool as part of the centralisation of water services away from local or indigenous control, and for ends pre-determined by state or private interests. The idea of water scarcity as constructed informs the reading of global urban drought risk literature in section 2.3, which presents both predicted urban drought risk (in sum: extremely high) and problematizes these predictions. Section 2.4 further contextualises urban drought risk by identifying the urban-rural divide in drought response, situating urban drought as a phenomenon that impacts entire regions and identifying another area of claims—that urban areas are coming for rural supplies—which can be addressed through this investigation. The literature review concludes with an overview of the use and efficacy of drought planning (section 2.5)—arguing it is necessary to understand within a network of city planning documents—as well as acknowledging questions of scale (section 2.6), as many efforts exist to foment national and regional-level drought planning, but which may be incomplete without local urban drought planning as well.

2.1 Drought Definitions

Depending on the context, discipline, and the specific impacts observed, drought can be defined in several ways, such as a concerted number of days without rain, or soil moisture deficits which develop over several months (Buurman et al., 2017; Mishra & Singh, 2010). Crausbay et al. (2020) argue that climate change is introducing novel forms of drought in cause and duration: e.g., snow drought, hotter drought, megadrought, flash drought, human-induced drought, and human-modified drought. Dracup et al. (1980), in a seminal work, identified three types of droughts: meteorological, agricultural, and hydrological. Meteorological drought is the most common use case and refers to a prolonged period of abnormally low precipitation; however, the degree and length of dryness which constitute a drought vary widely by location and context and can be measured in diverse ways, from the amount of rainfall in a specific period to long-term averages. Hydrological drought is characterized by reduced surface water and groundwater availability, measured by reduced water levels or decreased aggregate runoff (Van Loon, 2015). Agricultural drought is the difference between plant water demand and available water, marked by soil moisture deficits which reduce agricultural productivity. There is also ecological drought, which centres the effects of drought on ecosystem health and can be measured by biodiversity metrics and ecological processes (Cravens et al., 2021). Wilhite and Glantz (1985) add socio-economic drought to the conversation. Central to socio-economic drought is the difference between water supply and demand, and it is a valid definition of drought when a drought's triggers or thresholds are defined by socio-economic factors. Van Loon et al. (2016), however, disagree that socio-economic is a *type* of drought, saying rather that this term speaks to the socio-economic *impacts* of drought, and that what others are trying to express with this term is more accurately deemed as water scarcity due to some level of water mismanagement.

Thus, water scarcity is a closely related issue to drought. Water scarcity results from water management issues which create long-term water demand that exceeds long-term water supply. This includes the overexploitation of water supplies. Water scarcity can persist even in the absence of drought conditions due to other factors affecting water availability, accessibility, and usage (Van Loon & Van Lanen, 2013). Zhang et al. (2019) posit that urban drought is a temporary state, whereas water scarcity is long-term. That is, droughts can exacerbate conditions of water scarcity, but water scarcity can exist without drought conditions. Some use ‘water scarcity’ to describe an imbalance of water supply and demand and ‘drought’ as the trigger to this imbalanced state (Singh et al., 2021). Nonetheless, it is important to note that “socio-economic drought” is still a term used in practice by UN agencies, the World Meteorological Organization, and by water providers (Verbist et al., 2016).

However, some scholars argue that the definitions of drought, and the difference between drought and water scarcity, are pedantic discussions which serve to construe drought as a primarily natural phenomenon, obscuring the social or water management factors which may contribute to it (Elie, 2024; Savelli et al., 2022). Hydrologists since the 1980s have elucidated that drought is the extent to which the impact of a water deficit is felt by humans as compared to ‘normal’ conditions. This notion is in line with other disciplines of natural disaster research which have successfully demonstrated that disasters are complex social events—not purely natural phenomena (Oliver-Smith et al., 1999). In recognizing that social factors influence the impacts of natural disasters like earthquakes, the social drivers, impacts, and inequalities of these hazards are better analysed and addressed than for drought (Baxter, 2020; Elie, 2024; Garcia, 2016). This strain of thought aligns with arguments that water scarcity is best conceived as a socially constructed misallocation of water in society, rather than a passive, natural process.

2.2 Water Scarcity as Constructed

The concept of ‘scarcity’ as applied to natural resources emerged in the 1970s to try to understand whether there are limits to the biosphere’s ability to support human population growth and development, in the Malthusian tradition (Malthus, 2000; University of Sussex Science Policy Research Unit, 1973). In turn, critical scholars note that this is constructed, both in that the science supporting some concrete 'limit' is itself quite limited, and that consumption patterns are subject to social and cultural norms rather than innate and unsatiable. Further, they note the ways that this discourse has been used to justify interventions and accumulation of resources like water by governments and the private sector. (Huff & Mehta, 2019). Huff and Mehta (2019) contend that scarcity discourse manifests in three types of conceptions and associated solutions: *quantification*, wherein water is understood to have a static upper limit of availability; the *technological and managerial fix*, which calls for improvements in technology or management to 'avoid' scarcity; and *structural/distributional*, where scarcity results from the allocation of resources in society rather than as matter of fact.

Defining water according to these manifestations of scarcity reveals several problems. A quantified conception of water scarcity, wherein there is a supposed upper limit to the environmental availability and distribution of water worldwide (e.g., the Planetary Boundaries approach per Rockström et al. (2009)), is built on shaky data and homogenizes the state of water resources globally, although water has always differed in availability temporally and geographically (Puy & Lankford, 2024). The technological fix approach favours solutions to water scarcity such as desalination, the introduction of which can limit the implementation of other water development pathways, including water conservation (Lindsay et al., 2017; McEvoy, 2014), and de-politicizes the allocation of water in society (Swyngedouw & Williams, 2016; Williams, 2022). A structural or distributional view of water scarcity brings attention to gaps in water availability that may exist irrespective of local freshwater supplies, but still tends to aggregate information about water scarcity in a way that obfuscates social hierarchies which contribute to individual water deficits, such as unequal gendered access at the household scale (Fielding et al., 2012; Koppen, 2023).

The definition of a drought can affect how it is managed (Mehta et al., 2019). Varying definitions of drought contribute to difficulty in properly determining causes and solutions. Wilkins and Patterson (1990) argue that slow-onset events are prone to attribution problems, where audiences mistake the outcomes of the event for its causes, having ignored the slow stacking of environmental, social, and management decisions which contribute to the event. Because of the local nature of droughts, the World Meteorological Organization's *Handbook of Drought Indicators and Indices* does not make recommendations about which indicators are most useful, instead asking readers to apply local knowledge and experience with droughts to choose appropriate indicators (Pischke & Stefanski, 2016). Several studies explore how different stakeholders compete for different interpretations of drought events, in turn advocating for different management solutions (Mehta, 2003; Paneque Salgado & Vargas Molina, 2015; Sonnett et al., 2006). Aguilera-Klink et al., (2000) are among the first to identify this phenomenon, doing so for Tenerife by tracing the development of water resources from the 18th century onwards. They note that Tenerife has high natural water availability, which is why it was a prime site for Spanish colonisation. While initially creating a situation of even more water abundance, over decades, the development of water supply systems and exploitation of groundwater by private companies created water scarcity and made the island more vulnerable to drought impacts. However, the perception of drought as a purely natural process obscured the overexploitation of water for profit as a driving factor of this water scarcity.

Mehta (2003) is also a chief architect of the argument that whilst there are environmental drivers of drought, water scarcity is more a function of water allocation within society. Her example of India's Sardar Sarovar Project reveals that the state represented water issues as natural and chronic, rather than human-induced and cyclical, and enacted related changes to water management to the benefit of elites and to the detriment of community livelihood strategies which were adapted to cyclical water deficits—including reciprocal, informal water-sharing arrangements. She further notes that contributing factors like deforestation, overuse of aquifers, and the building of dams led to changes in the local hydrological cycle, which contributed to water scarcity but were obscured as causes due to their anthropogenic origins. Mehta argues that anthropogenic causes result in uneven impacts on households, wherein wealthier households can afford continued water access, while poorer households must make do with less. Finally, she concludes that scarcity was employed as a discourse to justify a singular, state-led solution in the form of a controversial dam. Santha and Sasidevan (2018) similarly found that the transition to state-led and controlled water management, even in a drought-stressed context, made issues of water scarcity worse for communities by adding centralized infrastructure which interrupted preexisting communal and reciprocal water networks. With new water infrastructure came the assignment of a maintenance and repair responsibility that was beyond the capacity of the local community—and indeed, beyond the competency of the Irrigation Department which installed it yet failed in its maintenance duties. A crucial finding was that mechanisms for accountability decreased in the transition to state-led infrastructure compared to the previous system of mutual benefit and strong social networks, as accountability moved from inter-personal to bureaucratic.

According to Van Loon and Gleeson, et al. (2016), water supply in highly engineered contexts like cities can be considered artificial due to all of the ways in which these systems are buffered from environmental conditions; the surface water levels of rivers within the city may not matter if the city procures its water from farther afield, for instance. They too lend to the idea that drought is no longer a purely natural hazard due to the many human inputs into most water systems. Their concept of anthropogenic drought echoes calls by Mehta (2003) to recognize human changes, like deforestation and dam building, which create environmental conditions that are more conducive to droughts. This highlights the ways hydrological and agricultural droughts in particular can be distinctly influenced by human management via water level drawdown and land use changes.

Similarly, Paneque Salgado and Vargas Molina (2015) explore the ways that different actors compete for priority during droughts in Spain, outlining how stakeholders frame drought impacts in order to advocate for management solutions which favour their sectors. It was revealed that the agricultural sector—the highest water user—had the most power, outcompeting even water agencies for drought response options which favoured agriculturalists. Müller (2020) found that the German government employed the same tactics in drought after drought, because the agricultural sector made the same requests to protect their industry each time. Kaika (2003) reveals a similar phenomenon in Greece, whereby the state's framing of a drought crisis served its pre-existing agenda to privatize the water sector. She finds patterns similar to Mehta (2003) and Van Loon and Gleeson, et al. (2016), where the water agency's previous management activities—such as overextraction and low prices—led to a status quo of overconsumption, particularly for the wealthy. Similarly, Simpson et al. (2020) make the case that the City of Cape Town suffered in part to a "dam mentality" during its 2015-2019 drought, which constrained potential responses to those which required bigger, better reservoirs—and in so doing, the city was unable to account for private and informal access to water which proliferated among its citizens and was in turn filled by the private sector. The public did not necessarily become more water-conscious through the drought (as in, more likely to conserve water) but in some cases instead attempted to buy themselves out of the crisis. Sonnett et al. (2006) observed that media coverage influenced drought management actions, where in the neighbouring states of Arizona and New Mexico, the same drought event was portrayed differently and resulted in New Mexico taking high-urgency, short-term mitigation actions, while Arizona continued with water management as usual.

Savelli et al. (2023) argue that urban drought is often a factor of elite's unsustainable water consumption. In a close examination of Cape Town's 2015-2019 water crisis, they find that overconsumption of water by privileged groups was one of the drought's causes, and that typical management strategies like increasing supply and raising tariffs were ineffective in targeting these water users. Increasing water supplies only served to reinforce levels of unsustainable water consumption for the most privileged, and tariffs did not prompt widespread behaviour change in this group, because they could afford the increased rates. In another examination of Cape Town, Muller (2018) points to poor water management in which the City did not heed projections about drought as early as 2009—a six year lead time—and failed to make appropriate investments in further water infrastructure or curb demand from the highest water users to create a bigger storage buffer against severe drought conditions. This article draws parallels with short-sighted water management decisions which exacerbated drought conditions in São Paulo, Barcelona, and Australia (ibid.). There is also evidence that decision-makers are acutely aware of political trade-offs during drought conditions, and recognize competing pressures between imposing water use restrictions and the potential political fallout of doing so. Dilling et al. (2019) and Mullin and Rubado (2017) note water managers' unwillingness to enact water use restrictions without a clear mandate to do so, which can be difficult to ascertain without an official drought plan or similar guidance document. But as Page and Dilling (2020) point out, political pressure to act or not act from stakeholders is interpreted by water managers in diverse ways, such that the same call can lead to different management actions.

2.3 A Nuanced View of Urban Drought Risk

A global rise in drought will increasingly impact urban areas, as the world continues to urbanise and water suppliers grapple with increasing customer demand (Forero-Ortiz et al., 2020; Greve et al., 2018; Schewe et al., 2014). Urban water customers across the world face water shortages and restrictions on use during drought (Buurman et al., 2017). Urban drought impacts can be direct, through a lack of water, uneven access to water, and lapses in hydropower supplies; and indirect, through increased food prices, supply-chain interruptions, decreased economic productivity, health issues in the population, and social unrest (Stolte et al., 2023).

There is no shortage of articles that claim an impending water crisis in cities, with staggering estimations and statistics (Gober, 2010; Guerreiro et al., 2018; Güneralp et al., 2015; Richter et al., 2013). Such claims have been made by UN agencies as early as 1991 (Swyngedouw, 1997) and reinforced through popular water texts (Gleick et al., 1993; Postel, 1992). McDonald et al. found that "523 million people are in cities where water availability may be an issue, 890 million people are in cities where water quality may be an issue, and 1.3 billion people are in cities where water delivery may be an issue" (2011, p. 437). In an analysis of 71 cities under a business-as-usual scenario (i.e., without accounting for additional losses due to climate change), 32 were predicted to be potentially unable to meet both urban demand and environmental minimum flow requirements going into 2040 (Padowski & Gorelick, 2014). McDonald et al. (2014) estimate that one in four large cities are water stressed. Flörke et al. (2018) find surface water deficits will result in increased conflict between rural and urban areas affecting up to 233 million people. Zhang et al. (2019) claim that 79 big cities have experienced drought so far in the 21st century. He et al. (2021) predict that the global urban population exposed to water scarcity will increase from 933 million in 2016 to 1.692-2.373 billion people in 2050, and that the number of large cities facing water scarcity will grow from 193 to 284. Table 1 displays these predictions.

Table 1. Predicted number of people and cities predicted to face urban water scarcity and/or drought in the literature.

Urban Population	Number of Cities
523 million people (McDonald et al., 2011)	32 of 71 examined (Padowski & Gorelick, 2014)
Up to 233 million people (Flörke et al., 2018)	1 in 4 large cities (McDonald et al., 2014)
Increase from 933 million in 2016 to 1.693–2.373 billion people in 2050 (He et al., 2021)	Increase from 193 to 284 large cities (He et al., 2021)
	79 big cities (Zhang et al., 2019)

These figures show high variation both in parameters and their results. The low estimation is up to 233 million people and just 32 cities; the high estimation gets up to nearly half the global population and one-fourth of large cities. The validity and applicability of these global models of urban drought risk have been called into question, as there is "reason enough to believe that global discourse on the water crisis is far more related to Western water management paradigms (which is inspired itself by modern hydrology) than to specific water problems in the so-called Global South" (Bruns & Frick-Trzebitzky, 2014, p. 417). Some also argue that the problems inherent to each modelled approach, although they may be the most advanced models possible, and the diversity of drought indices, render accurate global analysis of drought risk infeasible and are perhaps best left to smaller spatial scales (J. W. Hall & Leng, 2019). These studies tend to be highly disaggregated from local water management data and practices, as they necessitate input from global water datasets, even the best of which are incomplete by supply type and across continents. They often cannot account for groundwater supply due to the lack of global datasets about groundwater availability and withdrawals (Flörke et al., 2018; Gnann et al., 2023). Notably, many do not use primary data sources, either (Bruns & Frick-Trzebitzky, 2014). This prompts conclusions that are not supported on the ground or even agreed upon by some of their highlighted localities of concern. For example, Stolte et al. (2023) identify San Diego and Los Angeles, California, as drought hotspots, whilst numerous other studies use them as case studies exemplifying drought management best practices (Berbel & Esteban, 2019; Greene, 2021; Kuper et al., 2023; Milman & Kiparsky, 2020; Moore et al., 2021; Nemati et al., 2023; Soliman, 2022; Tortajada et al., 2017). This speaks to the separation between drought *monitoring/forecasting* and drought *management*, wherein the models which may be able to predict meteorological or hydrological drought are inept at accounting for the water management systems that exist to fend off the impacts of these events.

Furthermore, Linton and Saadé (2024) note that since the 1960s, these imperfect quantitative predictions have culminated in a sense that a global water crisis is unavoidable due to global 'limits' on water supply, rather than constructed by the allocation of water in society. They argue, like others, that this de-politicises issues of water management, thus favouring techno-managerial solutions, which may limit decision-makers' view of the problem and associated solutions (Linton & Saadé, 2024; Williams & Swyngedouw, 2018). Román (2010) explains that these aggregate models obscure variation across cities, even though urban consumption patterns unique to each city often drive disparate impacts on urban populaces. How cities experience drought, and the extent of their vulnerability to drought, is in part dependent on their patterns of water demand. Seasonality of demand is an important component of managing urban drought impacts, because high demands tend to peak in the summer (for cooling and landscape irrigation) when heat and low precipitation may be at their worst (Finley & Basu, 2020). Thus, drought and water scarcity can occur even in cities with high average annual rainfall; if rainfall does not come at the right time, a spike in urban water demand can strain supplies with little forewarning (ibid.). Indeed, this coupling of water demand spikes spurred by extreme heat and variations in typical precipitation patterns is an increasing challenge for urban water suppliers under climate change conditions.

2.4 The Urban-Rural Drought Divide

There is a strand of literature identifying cities as a force seeking to urbanize, which requires increasing amounts of water taken from the surrounding—"surrounding" sometimes being miles away—regional environment, in a vast hydraulic reach (Scott & Pablos, 2011), to the detriment and subjugation of rural areas (Herod & Wright, 2002; Scott et al., 2007; Swyngedouw, 1997). Swyngedouw (1997) maintains that urbanisation itself necessitates vast amounts of water and is accompanied by entrenched processes of capital accumulation and commodification which require water. It is also recognized that urban areas have acute impacts on their surrounding environments, by changing evapotranspiration and runoff rates as vegetation gives way to hardscapes (Romero-Lankao & Gnatz, 2016).

Much drought literature focuses on agricultural impacts, as that is the sector that is most vulnerable to drought conditions. Crop losses are the most acute danger from drought conditions in the short-term, and loss of soil moisture can lead to long-term problems as well (Singh et al., 2021). Rain-fed agricultural systems are particularly at risk, as are areas that are overwhelmingly dependent on surface water supplies and lack water storage. However, irrigated agricultural systems are also highly vulnerable to drought—not only because of reductions in water availability, but also due to the threat of water reallocation to other users during emergencies, especially urban areas. Some urban areas, for example, explicitly account for the potential to buy 'retired' agricultural water rights during drought or to prepare for drought (Hornberger et al., 2015).

There are disparities between urban and rural water use, where generally, urban residential and domestic water demand is typically lesser than rural agricultural water demand (Padowski & Gorelick, 2014; Richter et al., 2013). They also have different patterns of consumptive and non-consumptive use, in terms of water that is returned to the water basin system as wastewater, wherein landscape applications are typically consumptive uses—though it can depend on the irrigation system and watershed topography in question (Hooper, 2015). A driving factor of concern over urban drought is water basin closure, wherein water systems are over-allocated among uses (urban or rural alike) with no buffer available should shortage occur in any sector (Molle et al., 2010). This causes some to conclude that there is little urban areas can do inside city boundaries to impact water scarcity or protect themselves from drought—thus necessitating partnerships or financing changes to agricultural water use (Richter et al., 2013). Urban drought risk management is nested within other social-ecological systems and administrative levels, including both natural boundaries (in a river basin or catchment) and governance structures (through interactions at multiple levels of government) (Buurman et al., 2017; Cantor, 2021). There is a tension in the literature between rural and urban water uses, wherein it is largely theorized that rural water supplies will be transferred to urban areas under conditions of water scarcity exacerbated by drought. Some studies explicitly state that modest gains in agricultural water use efficiency would "free up" enough water to make up for shortcomings in urban supplies (Flörke et al., 2018). Some claim this is a justice or food security issue for farmers, ranchers, and other agriculturalists (Zeff et al., 2016), while others note that privileging commercial farmers—an elite class of businesses and landowners—can be unjust as well (Vogel & Olivier, 2019). But this space still requires much research. Emerging literature suggests, for example, that addressing water quality issues could alleviate water scarcity among urban and rural users alike, with fewer trade-offs and greater overall benefits (Baccour et al., 2024).

In a systematic review of the topic, Garrick et al. (2019) find few trends among water reallocation projects, besides geographic distribution biased to formalised projects in North America and Asia. Thus, they recommend that more rigorous studies be done to understand the efficacy of reallocation projects. Water transfers do occur from rural to urban uses, but more scrutiny is needed to determine the actors and governance mechanisms that drive this process (Scott et al., 2007). Müller (2020) finds that farmers politicise drought to protect their income and subsidies, prompting the same state interventions drought event after drought event. Through a case study approach, Hooper (2015) calls attention to the outsized tendency of water allocation literature to represent agriculture-to-urban transfers as zero-sum, without full accounting of changing socioeconomic conditions, and calls into question the validity of urban versus rural as distinct sectors, particularly in peri-urban areas. She calls attention to the non-water ways in which urbanisation influences agriculture, such as through the migration of labour, which have bearing on metrics like agricultural productivity that are used to gauge the impact of reallocation in the literature. Additionally, gains in crop productivity are possible with both reduced water input and irrigated area (Celio et al., 2010). Empirical evidence further suggests that cities obtain additional water without conflict with rural or agricultural uses—often turning to groundwater exploitation if it is available—and are more likely to encounter crisis if they lack institutional or financial capacity to reduce the impacts of water scarcity (Molle & Berkoff, 2006). This is also true for agricultural users (Celio et al., 2010).

2.5 The Use and Efficacy of Drought Planning

Drought planning is a potentially under-developed planning area, with some scholars calling it 'reactive' rather than striving for drought risk management (Buurman et al., 2017; Rossi & Cancelliere, 2013; Wilhite, 2016). Pischke and Stefanski say a crisis management approach to drought is "untimely, poorly coordinated, disintegrated and provides negative incentives for adapting to a changing climate," thus necessitating interventions like the UN's efforts to normalise national drought planning (2016, p. 228). Drought plan prevalence is relatively low globally, and drought is often absent from similar planning areas such as hazard mitigation (Wickham et al., 2019). Proactive drought risk management is essential for water management; Buurman et al. (2017) note that long-term planning and strategy evaluation can mark the difference between crisis management and true drought risk management, which reduces overall impacts and vulnerability. There are two approaches to drought management: (1) long-term strategic planning, which includes pre-determining appropriate mitigation actions and investments to reduce drought vulnerability, and (2) short-term actions, which are implemented during a drought event, which may or may not have been pre-determined through a planning process. Long-term strategic planning supports a risk management approach with efforts to reduce the likelihood of drought occurrence and reduce vulnerability to drought impacts (Gutiérrez et al., 2014). Short-term actions are ‘crisis management’ when they are not prepared in advance; although pre-planned actions can include crisis management strategies to employ during drought as last resorts (Rossi & Cancelliere, 2013).

Drought planning drivers vary. Aridity or threat of drought are not the only explanations for the presence of a drought plan; it can also be driven by desire for system reliability, institutional culture, policy leanings, and political pressure (Gilligan et al., 2018; Hornberger et al., 2015; Mullin & Rubado, 2017). Haigh et al. (2022) note that the presence of a hazard plan is more likely if that city has experienced hazard in the past, suggesting experience as a driver for planning. In a systemic review of pre-disaster planning for floods and drought in developed nations, Raikes et al. (2019) found a lack of legislative and policy frameworks to reduce the risk of these hazards; flood planning and preparedness far outpace drought in disaster literature, and flood management is evolving towards a risk-oriented approach but drought response continues to be characterised by crisis management. They note a lack of monitoring and early-warning systems within disaster literature for drought, which may contribute to a reliance on the crisis management approach.

The goal of drought planning is to establish procedures during drought events, both in terms of water provider actions and in establishing thresholds by which to reduce water consumption in different sectors or customer classes (M. Hall, 2014; Hornberger et al., 2015). Drought planning occurs via at least three stages: forecasting and warning, risk assessment, and mitigation/response (Engle, 2013). In practice, countries like the United Kingdom have added a fourth stage: official declaration of the end of a drought based on ecological factors, with review of how the drought was managed (Parry et al., 2016).

The goals of drought management are typically to increase water supply, reduce water demand, and reduce drought impact (Rossi & Cancelliere, 2013). The actions for doing so are quite diverse, but fall into the categories of increasing water supplies, reducing water demands, and increasing the use efficiency of supplies (Rijke et al., 2014). Figure 2 demonstrates the possible range of drought management options available to water managers, though research has shown a predominant interest in increasing water supplies and limited employment of other drought mitigation measures (Buurman et al., 2017; Grecksch & Landström, 2021; Hornberger et al., 2015). While this figure results from research specific to the England and Wales drought planning context, it provides a useful example that is applicable to water providers worldwide, though specific mechanisms and terms may differ.

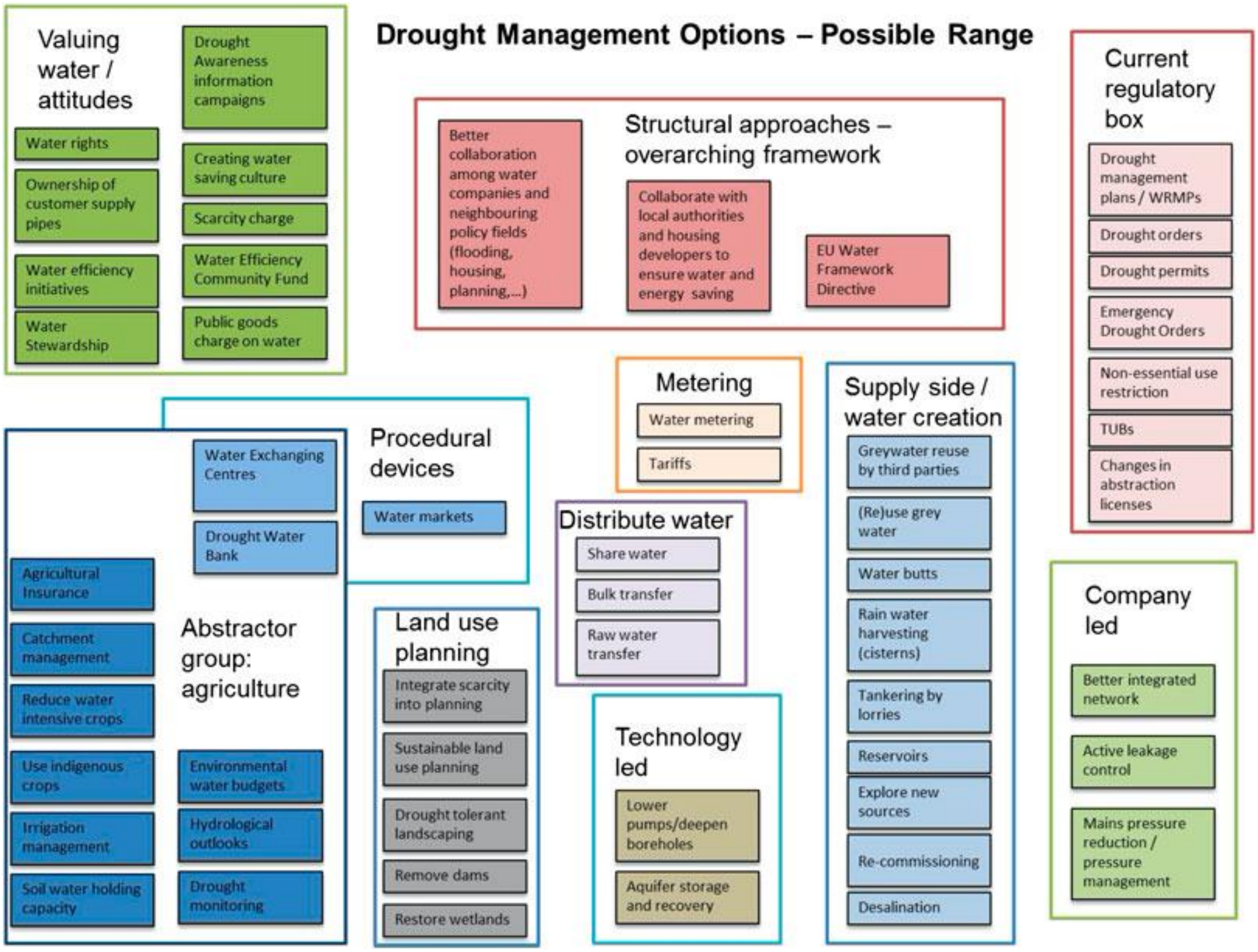

Figure 2. Suite of drought management options that can be employed by water companies in England and Wales (Grecksch and Landström, 2021).

Managing behavioural change to promote water conservation can be difficult during drought. Studies show individual and household aversions to water restrictions, with a high willingness to pay to avoid such restrictions. This has negative social equity implications for poorer households which cannot afford high water tariffs (Brennan et al., 2007; Cooper et al., 2011; Hensher et al., 2006). Kenney (2014) finds two main disincentives for water providers to pursue water conservation: the idea of 'demand hardening,' wherein too strict of water use curtailments would inhibit further curtailments in the future; and revenue-based, which exposes a fear that water providers would lose out on revenue—to the extent of potential business failings—if water use is reduced too significantly. But other studies find that drought response can profoundly impact local water use culture and in turn influence public support for water policy. This is particularly pertinent in urban contexts, where water providers have more direct influence on water use behaviour through water management policy. Lindsay et al. (2017) compared three Australian cities that underwent long-term drought and found that a culture of water conservation persisted in Brisbane and Melbourne due to residents taking on a sense of crisis, whereas in Perth, where desalination was pursued aggressively, there was little individual uptake of water conservation responsibility and thus little change in water use behaviour. They also discovered increased support for further desalination interventions in Perth as a result of resident's positive experiences with desalinated water supplies—to the detriment of support for water conservation policies. Kallis (2010) argues that individual water use practices coevolve with drought mitigation strategies, finding that technical solutions to increase water supplies in Athens led to increased water use among residents, which then impeded implementing water conservation initiatives.

The efficacy of drought planning is debated in the literature. Even under mandatory water reductions, water providers and consumers can have trouble cutting demand to desired rates (Palazzo et al., 2017). Del Moral Ituarte and Giansante (2000) noted that heavy supply-side planning was a constraint to effective drought management in Spain and hypothesized that focus on augmenting water supplies made Seville more at-risk to drought. Similarly, Gómez Gómez and Pérez Blanco (2012) postulated that implementing a new drought plan in Spain's Segura River Basin would increase surface water deficits, in part because it did not account for groundwater abstraction. Cravens et al. (2021), by creating a typology to describe decision-making during drought, reveal the multitude of actors (beyond water managers) that are involved in drought-related decisions and subsequently reveal that drought plans can be secondary or tertiary influences on this decision-making. Bettini et al. (2015) echo this, finding that powers non-exclusive to the planning process—the ability to learn, decide, and act—categorised adaptive capacity in two Australian cities during drought. Planning is situated in "learning" here, in recognition that the efficacy of a drought plan only partially informs drought response. Vogel and Olivier (2019) note the importance of ongoing drought preparedness efforts—difficult to achieve as the problem of drought fades—that are inclusive of grassroots knowledge in addition to scientific perspectives.

Haigh et al. (2022) found that standalone drought plans are uncommon, preceded in likelihood by including drought subsections in water plans, hazard mitigation plans, and even local comprehensive land use plans. Indeed, planners were ambivalent about writing separate drought plans, ranking it beneath including drought within other planning areas (ibid.).

Theoretical and quantitative models dominate the literature evaluating urban drought planning and preparedness, most of which attempt to describe urban water supply resilience. Many studies conclude, simply, that the urban water systems best prepared for drought should have access to as many supply types as possible while pursuing water conservation strategies across their customer base (Rushforth et al., 2020). Some metrics for water supply resilience use the number of supplies available as indicative of more resilience (C40 Cities, 2022b). Dilling et al. (2019) find drought response actions are effective when they reduce water demand and maintain system reliability. The limits to adaptive capacity were drought response actions which decreased operational flexibility, met public resistance, were hard to measure in terms of water demand reduction, and which threatened the viability of existing revenue structures (ibid.). Others also claim that drought planning is most effective when integrated into other planning areas, like climate or resilience planning (Finnessey et al., 2016). However, there are many barriers to this kind of integrated planning, including lack of capacity (even among very developed cities) and difficulty in understanding and defining drought events and their impacts (American Planning Association, 2019). Thus, ways of determining drought preparedness and measuring the efficacy of drought plans and related strategies still has room to grow and become more precise, both in the literature and in planning practice.

However, planning as a process, in addition to helping systems move toward more proactive risk management approaches, creates the opportunity for more advanced decision-making. Matrosov et al. (2015) find through modelling that increased water conservation in London could reduce the need for a new desalination plant or water reuse system. Some scholars argue that the utility of drought planning lies in part in establishing procedures for coordinated action across planning silos (e.g., land use planning and water utilities) which otherwise do not collaborate (Gutiérrez et al., 2014; Haigh et al., 2022). The planning process can also help water providers realize the need for regional-scale solutions and reveal the benefits of regional cooperation (Zeff et al., 2016). Drought plans are primarily operational in nature but, like all plans, are important documents which 'signal' ideal futures, not only for water managers and city planners, but also for stakeholders such as citizens and developers (Hopkins & Knaap, 2018).

2.6 Scale of Action – Limits to Top-Down Drought Planning

Given that drought planning is a fairly unstandardized practice, the scale at which it exists varies worldwide. Garrick notes that there is an 'assignment challenge' for drought management and adaptation, wherein there is a "challenge of assigning and coordinating governance responsibilities across nested levels of social organization" (2018, p. 301). Findings from an analysis of drought management through the lens of this 'assignment challenge' revealed a need for intervention at all scales, from individual to inter-governmental (ibid.). There have been global initiatives to increase drought planning at the national level, with the United Nations Convention to Combat Desertification forming a Drought Initiative in 2018 to promote the creation of national drought plans, with associated resources and model plans to support such preparation (UNCCD, n.d.-c). This has resulted in 34 verified, publicly available national drought plans (UNCCD, n.d.-a). Additionally, the International Drought Resilience Alliance was established in 2022, and is now comprised of 36 supporting countries (UNCCD, n.d.-b). Drought planning is an optional component under the European Union's Water Framework Directive, in which case it is conducted alongside Basin Management Plans at the basin management level (Rossi & Cancelliere, 2013). However, 19 out of 27 European Union Member States have legislated drought mitigation to some extent, and 13 have some form of drought management plan, be it at the national, basin-level, or local scale (Schmidt et al., 2023).

Research from the United States shows that state-level drought plans are strong in emergency response but weak in proactive management—to the detriment of improving local drought resilience (Fu, Svoboda, et al., 2013). Local drought planning is less common than at the state level, which implies a gap in local drought preparedness by water providers (Haigh et al., 2022). Engle (2013) found that drought planning at the state level tended to be too generic to allow for locally relevant actions. Nonetheless, state frameworks for drought planning created clear boundaries for action at the local level and provided a support structure for local drought mitigation. Similarly, Fontaine et al. (2014), in interviews with state drought officials, reveals a lack of focus on proactive drought planning and a need for more robust monitoring and prediction tools. This is echoed in Canada, with the additional problem of cities needing to rely upon provincial Ministries to enforce water restrictions during drought (Durley & de Loë, 2005). Aguilar-Barajas et al. (2016) trace the development of Mexico's national drought policy, which exists as a subset of its national water programmes. They find this approach to be insufficient for addressing and mitigating drought, as drought risks are coupled with flood risks—despite the very different needs and protocols for dealing with these disasters—and flood risks receive much more concerted attention and funding.

Makaya et al. (2020) discover limits to drought management techniques which centre the state and which do not account for local culture, finding that drought mitigation resources were unevenly distributed across South African villages, and that residents such as farmers had an outsized hardship in adapting to drought because they believed it was caused by an act of God, and thus action was futile or in defiance of their religious beliefs. Verbist et al. (2016) call for improved proactive management of drought to reduce vulnerability in Africa and the Caribbean, though they also note that drought management policies require stronger warning systems and institutional capacity. This demonstrates the limits to solely top-down approaches to drought management and the gap between drought preparedness mechanisms and the uptake of those mechanisms among those who must adapt to drought conditions.

3 Research Gaps, Theoretical Framework, and Objectives

The literature review reveals many trends in urban drought planning literature, as well as many gaps in existing scholarship. There is a trend within drought research where the social sciences are secondary to scientific and hydrological interpretation—a trend that is less prevalent in flooding and natural disaster literature (Elie, 2024; Savelli et al., 2022). Further, drought literature tends to focus on agricultural impacts in primarily economic terms; not without justification, for, as noted, rain-fed agricultural systems often face the first drought impacts, and irrigation-fed agricultural systems which use the majority of water in a region are subject to reallocation of water (Berbel & Esteban, 2019; Garrick et al., 2019). These studies do not capture the full complexity of drought impacts, nor do they often engage with drivers like intensive agricultural production which may also contribute to negative impacts that become attributed solely to drought (Savelli et al., 2022). Additionally, given the impacts of urban drought can be severe and the prediction that urban drought is expected to become more prevalent and worsen under climate change, more investigation into urban drought preparedness is warranted (Bruns & Frick-Trzebitzky, 2014; Cai et al., 2018). Further, there is a gap in analysing and understanding the perspectives of cities regarding issues of drought; on the one hand, a large body of literature predicts further urban water scarcity and reallocation of water from rural to urban areas (Flörke et al., 2018; Greve et al., 2018); on the other hand, a body of literature traces the framing of drought as portrayed in media and official documents during active drought events, but often does not investigate these questions within city planning documents (Mehta, 2003; Sonnett et al., 2006). Studies about drought planning tend to try to gauge the efficacy of plans and the perspectives of planners—taking for granted more fundamental questions about the positionality of such plans in the first place (Fu, Tang, et al., 2013; Gómez Gómez & Pérez Blanco, 2012; Haigh et al., 2022). Relatedly, there are calls for more engagement with critical social sciences in drought scholarship (Savelli et al., 2022)—a call this paper will heed through a drought framing analysis.

3.1 Theoretical Framework: Issue Framing

"Framing" as a concept is rooted in the study of communication and public policy that has been applied to topics ranging from natural resources to immigration (McQuail, 1987; van Hulst & Yanow, 2016). Originating in the 1970s to understand how agencies create and assign meaning to policy problems—to understand *frames* themselves (Entman, 1993; Goffman, 1974; Rein, 1983)—it was expanded in 2016 to better account for the process of frame creation, i.e., *framing* (van Hulst & Yanow, 2016). Van Hulst and Yanow's (2016) definition of "framing" assumes that the way issues are presented by institutions is organic and emergent, rather than informed by active conscious thought or strategy, yet that the framing process creates understanding between the formation of a problem definition and its resultant solutions. This concept is useful for this study, given the aforementioned narrative of drought as an inevitable creeping global crisis, which this study seeks to verify or problematize at the city level, as well as to understand whether there is a material impact of the varying definitions of drought on response in practice. As noted by several scholars, adaptation to drought is an increasingly politicized process which prioritises some solutions whilst neglecting others (Kaika, 2003; Mehta, 2003; Müller & Kruse, 2021). The framing of drought by decision-makers “determines which aspects of the problem are addressed, where managers seek relevant knowledge, and which solutions are considered pertinent” (Cravens et al., 2021, p. 4). Framing is also relevant to urban planning, given that plans are signals both of a desired future state in a city to be achieved through city management interventions and as useful indicators of potential development pathways to developers, industry, and residents (Hopkins & Knaap, 2018). Particularly relevant to drought planning, given the diverse and contested nature of definitions of drought (Van Loon, Stahl, et al., 2016), is the idea of “framing as sense-making work,” (van Hulst & Yanow, 2016, p. 97), where identifying inputs is an important component in understanding the resultant issue framing, as these inputs represent the knowledge that is considered relevant to guide action (Taylor et al., 2021). O’Lear et al. stress that sense-making entails “material and ideological power” (2020, p. 161) which are central to decision-making about environmental issues, and which can be revealed through discourse analysis (Bruns & Frick-Trzebitzky, 2014).

There is precedent for using issue framing to investigate drought issues. Sullivan and White (2020) examined the framing of climate change in water-related planning documents in four drought-prone US cities. Müller and Kruse (2021) identify four ways in which drought is framed by climate change—a process called climatization—across affected sectors in Germany. Cravens et al. (2021) create a typology for understanding drought decision-making using four dimensions, one of which is issue framing. Omari Motsumi et al. (2023) investigate the framing of drought in Botswana during the 2015-2016 drought, finding that its framing prevented actions that reduce risk. Framing is also widely applied to investigate issues of flood management and response (Laeni et al., 2019; Meerow & Neuner, 2021) and issues of urban resilience more generally (Jon & Reghezza-Zitt, 2020; Muñoz-Erickson et al., 2021; Roberts et al., 2020; Sutherland et al., 2019).

3.2 Research Questions and Objectives

This study’s research questions are nested within the three narratives about urban drought identified from the literature review: the global warnings of impending urban water scarcity; the threat of reallocation of water supplies from rural to urban areas; and the idea of water scarcity as a constructed phenomenon due to the allocation and management of water in society. Issue framing is used to parse out the reality of these contestations within city plans. Table 2 demonstrates the connection between claims in urban drought literature, the gaps these claims create, and the research questions and objectives this study strives to address.

Table 2. Research design matrix connecting gaps in the literature to research questions and objectives.

Claim within the Literature	Gap(s) in Understanding	Research Question	Objective(s)
1. Urban drought risk is rising globally, with certain regions and cities particularly at risk.	These studies are often done without primary data from cities. This includes that modelled predictions of urban drought risk are usually dependent solely on hydrological models which may not fully account for a city's water management strategies.	**RQ1. How are urban drought risks framed and justified by cities?**	Ground-truth aspects of the global water crisis narrative with primary data from cities and determine extent of alignment with global narratives.
2. Because of rising urban drought risk, cities will increase their 'hydraulic reach' into rural areas.	The role of cities in planning or pre-determining these actions are unclear, with many studies revealing the influence of higher level of government in reallocation schemes.	**RQ2. Do issues of urban-rural water allocation emerge in urban planning processes?**	Reveal whether urban encroachment on rural water supplies is a pre-determined and active drought management strategy among cities.
3. The way water problems are framed may justify limited solutions.	There are limited studies which investigate this process within urban and water planning documents, and none which do so at scale.	**RQ3. Does the framing of drought impact chosen drought management strategies?**	Investigate whether there is a connection between different drought frames and associated solutions in practice.
4. Water scarcity (and relatedly, drought impacts) emerges due to the uneven allocation of water within society.	It is unknown the extent to which urban water managers may attribute human causes to urban water scarcity/drought and unclear whether certain sectors face disproportionate drought burdens.	**RQ4. Does the framing of drought impact the distribution of drought management strategies among users?**	Reveal whether the distribution of drought management responsibilities or burdens is dependent upon framing.

The Results section of this paper is organised according to each research question. Each is further answered within the Discussion section, with reference back to these objectives and the gaps within the literature.

4 Methodology

Interrogating instances of issue framing and whether certain solutions result from these framings necessitates the method of qualitative content analysis. Qualitative content analysis is a useful methodology to systematically examine how official documents create and perpetuate a status quo through the discourse employed therein (Bruns & Frick-Trzebitzky, 2014). This follows the Foucauldian poststructuralist conception of discourse, which posits that the power of discourse—and the actors who create it—lies in its ability to create a limited range of options for resolving a problem (DeLyser et al., 2009). It also engages with the notion of governmentality, given that urban planning is not a formal policymaking process (in that it may not directly result in enforceable rules or regulations) nor one superimposed upon the public, but that influences the management of people's lives (Foucault, 1982; Svarstad et al., 2018). This study uses discourse analysis to connect sense-making with problem naming and problem solutions. This is in line with observations both in issue framing and in water scarcity literature about how the way problems are presented shapes proposed responses to the detriment of holistic and multi-faceted problem-solving (Linton & Saadé, 2024; Mehta, 2003; van Hulst & Yanow, 2016).

This study is concerned with the framing of lapses in water availability in urban areas. Given the variety of drought definitions, some of which include water scarcity and others which do not, these terms are used in tandem, and are both investigated within the data sources.

4.1 Research Scope

4.1.1 Selected Cases and Justification

The cities under review were selected due to membership in either C40 or RCN. Participation in either of these networks was useful for multiple reasons: these networks collate plans from their participants in English, facilitating the process of finding and analysing a network of plans for this study; and because drought is a hazard which is often featured in Climate Adaptation Plans (CAPs) or Resilience Strategies (RSs). This latter consideration was important, because cities were selected based on whether they identified drought as a hazard within either their CAP or RS, in order to create a cohort which would have primary data about drought risk and mitigation—regardless of global metrics like annual precipitation which can obscure drought risk. This aspect of research design lends to filling the gap in the literature wherein global drought studies often do not engage with primary data from cities. These networks also both have water-related programmes which feature drought. C40 initiated a Water-Safe Cities project with drought as one of four priority areas, warning that “C40 cities will face surface water losses of more than 16.1 billion m^3 a year, which is equivalent to Sydney Harbour drying up 30 times over” (C40 Cities, 2022a). RCN has a longer standing, but less active, water-related subgroup, which created the City Water Resilience Approach in 2018—documents from which make up some of the data sources for this analysis (Resilient Cities Network, 2022b).

4.1.2 Selected Data Sources and Justification

The data sources analysed in this study are urban planning documents related to drought definition and mitigation. These include but are not limited to drought plans, water resource management plans, climate adaptation plans, resilience strategies, and related documents by similar names. The questionable efficacy of drought plans revealed by the literature review (Buurman et al., 2017; Gómez Gómez & Pérez Blanco, 2012), and the challenges of addressing problems which cut across urban domains, necessitates an analysis of a city’s network of plans (S. Woodruff et al., 2022). Herod and Wright (2002) warn against the trend in urban studies to assume the whole urban system is represented when only part of the city has been meaningfully studied. Planning documents emerge and exist in a tangled web of city management, which can change and shift according to organizational norms, legislative mandates from within and outside the city, and the discretion of city leaders (Hopkins & Knaap, 2018). As such, a city may define and problem-solve around drought across several documents, which may or may not include a discrete drought plan, or may describe the problem in one plan and delineate strategies for solving it in another (S. C. Woodruff et al., 2022). Further, in the absence of standardising legislation or planning practice, each city can approach drought planning in a different manner, resulting in different types of plans being created, or with unique naming conventions (Berke et al., 2015). Additionally, the scale of water management varies across cities, depending on whether the water provider is a city department or a separate entity—private or otherwise—and whether it operates at a basin or regional scale (O’Lear et al., 2020).

Assessing a network of plans is common practice for investigating the resilience of a community to hazards, and carries the benefit of being holistic, such that the content analysed is not dependent on the quality of any one particular plan (Berke et al., 2015; S. Woodruff et al., 2022). Indeed, a networked approach has been employed for many studies of urban flood resilience, and authors argue that this is because flood resilience (or lack thereof) results from this collective of plans (Meerow et al., 2024; Roy et al., 2024; S. Woodruff et al., 2022). Integration into a city's network of plans also contributes to drought mitigation moving from an emergency management approach to proactive preparation (Buurman et al., 2017; Makaya et al., 2020). Not all plans intend to address drought, but a network of plans approach reinforces that drought mitigation efforts need to be coordinated across relevant agencies and integrated into multiple forms of decision-making. Finally, the use of official government documents is important in urban adaptation research as it provides a consistent dataset, and city membership in C40 and RCN further boosts consistency across CAPs and RSs (Ford & Berrang-Ford, 2016).

4.2 Data Collection

4.2.1 Step One: Narrowing the Field to Drought-Concerned Cities

The CAPs of all C40 Cities were collected from C40's information hub for climate adaptation plans (C40, 2022). The CAPs of all C40 Cities that were in English were queried for "drought" and "water scarcity" to identify cities which recognize drought as a threat. Of 70 C40 Cities with a CAP, 53 were available in English. Of those 53, 39 mentioned "drought," "water scarce," or "water scarcity." These cases were verified to ensure that the city considers these a threat within their own boundaries, as many cities simply list these as threats worldwide due to climate change, or include a case study (often about Cape Town) to demonstrate municipal progress on climate change adaptation. After verification, there were 37 cities identified which consider drought an impending threat under climate change—and thus are likely candidates to consider drought across their networks of plans.

Then, the RSs were collected from the RCN's webpage for each member city (Resilient Cities Network, 2022a). The RSs of all RCN cities that were in English were queried for "drought" and "water scarcity" to identify cities which recognize drought as a threat. Of 85 RCN cities with an RS, 82 were available in English. Of those 82, 50 mentioned "drought," "water scarce," or "water scarcity." These cases were verified to ensure that the city considers these a threat within their own boundaries. After verification, there were 42 cities identified which consider drought an impending threat under climate change—and thus are likely candidates to consider drought across their networks of plans.

Between C40 and RCN, a total of 65 cities in 33 countries identify drought as a threat in either their CAP or RS—22 unique to C40, 24 unique to RCN, and 19 cities overlapping between the two networks. Thus, there were 65 initial cities in the study cohort prior to further narrowing by finding their network of drought-related plans.

4.2.2 Step Two: Finding the Network of Drought-Related Plans

For each of the 65 cities, the following plans were searched for: CAPs, RSs, Water Resource Management Plans (WRMPs), and Drought Plans (DPs). CAPs and RSs were searched for when they were not available via the C40 or RCN websites. Plans were searched for on a city-by-city basis through a two-step process (Ford & Berrang-Ford, 2016). First, the city municipal website was found and searched for each plan, both in the website's search bar and through scanning the relevant department pages. If plans were still missing, then a search was conducted through Google using the plan type and city name. The first five pages (50 results) were reviewed. If a plan was not found through these steps, it was marked as unavailable. Through this process, the CAP and RS were also verified to ensure they were the most up-to-date versions. These naming conventions were used to guide the search; but if a similar plan appeared and had a different title, it was still counted within the relevant category. Plans were considered to fall under the WRMPs umbrella if they address and plan for long-term water supply and management. Plans were considered to fall under the DP umbrella if they addressed protocols or solutions for managing water shortages including droughts. Other types of water plans, like Water Efficiency Plans, were considered as "other" plans. Additional "other" plans, like Hazard Mitigation Plans, were collected as was relevant and as appeared organically to further supplement each city's network of plans. Water providers were searched as well, using the same methods, if the city's water provider is an agency that is not part of the municipality, such as a private water company. In one instance, the cities of Berkeley and Oakland were combined into one case, as they share the same water provider.

Documents were considered plans if they were produced by or at the behest of the municipal government or its water provider to guide strategic action by municipal authorities. Plans prepared by international planning consultancies, such as Arup, were considered to meet this criterion when done in collaboration with the city. City or water profiles created by development organizations were not considered to meet this criterion.

If a city did not have at least three of the four of CAP, RS, WRMP, or DP, it was ultimately excluded from analysis. Further, if it did not have at least these three types of plans in English, it was also excluded from analysis. Plans with distinct planning horizons which have already passed (e.g., “CAP for 2015-2020”) were excluded. Draft plans that are still under review and public comment were also excluded. Scales larger than regional (e.g., statewide or nationwide water-related plans) were not considered, with the exception of Singapore as a city-state.

In total, 30 cities and 123 plans were included for analysis across 10 countries. Figure 3 shows the spatial distribution of cities worldwide. Table 3 contains the cities and each plan analysed, organised by region.

Figure 3. A map of the cities analysed within this study.

Table 3. A listing of the cities and plans (with assigned shorthand titles) analysed within this study, by region.

City	Plan 1 Title	Plan 2 Title	Plan 3 Title	Plan 4 Title	Plan 5 Title	Plan 6 Title
Africa						
Addis Ababa, Ethiopia	Addis Ababa CAP 2021	Addis Ababa RS 2020	Addis Ababa Water Resilience Profile 2021			
Cape Town, South Africa	Cape Town CAP 2021	Cape Town RS 2019	Cape Town Critical Water Shortages 2017	Cape Town Critical Water Shortages 2018	Cape Town Climate Strategy 2021	Cape Town Water Strategy 2019
Durban (eThekwini), South Africa	Durban CAP 2019	Durban RS 2017	Durban Water Policy 2021	Durban Municipal Adaptation Plans 2009	Durban Sustainability Best Practice Water 2007	
Johannesburg, South Africa	Johannesburg CAP 2021	Johannesburg City Resilience Profile 2022	Johannesburg Water Resilience 2023	Johannesburg Water Security Strategy 2022		
Asia (India)						
Bengaluru, India	Bengaluru CAP and RS 2023	Bengaluru Water Supply Project 2017	Bengaluru Water Board Vision 2018	Bangalore Plan for Infrastructure 2014		
Chennai, India	Chennai CAP 2022	Chennai RS 2019	Chennai Water Assessment 2021			
Pune, India	Pune CAP 2022	Pune RS 2019	Pune Water Supply System 2014	Pune Groundwater Management Plan 2022		
Europe (United Kingdom)						
Bristol, United Kingdom	Bristol CAP 2020	Bristol RS 2016	Bristol DP 2022			
London, United Kingdom	London Net Zero 2022	London RS 2020	Thames Water DP 2022			
Manchester, United Kingdom	Manchester CAP 2020	Manchester RS 2021	Manchester DP 2022			
Middle East (Jordan)						
Amman, Jordan	Amman CAP 2019	Amman RS 2017	Amman Water Resilience Report 2018	Amman Green City Action Plan 2021		
North America						
Calgary, Canada	Calgary CAP 2023	Calgary RS 2019	Calgary DP 2023			
Vancouver, Canada	Vancouver CAP 2024	Vancouver Climate Emergency 2020	Vancouver RS 2019	Vancouver Water Supply Outlook 2019	Vancouver Water Conservation 2021	
Atlanta, United States	Atlanta CAP 2015	Atlanta RS 2017	Atlanta WRMP 2022	Atlanta DP 2022		
Austin, United States	Austin CAP 2018	Austin RS 2023	Austin WRMP 2018	Austin DP 2024	Austin Hazard Mitigation Plan 2021	Austin Climate Equity 2020
Berkeley and Oakland, United States	Berkeley CAP 2009	Berkeley RS 2016	Oakland CAP 2020	Oakland RS 2016	East Bay WRMP 2020	East Bay DP 2020
Boulder, United States	Boulder CAP 2021	Boulder DP 2022	Boulder Hazard Mitigation Plan 2022	Boulder Water Efficiency Plan 2024		
Dallas, United States	Dallas CAP 2021	Dallas RS 2018	Dallas DP 2019	Dallas Water Conservation Plan 2019		
El Paso, United States	El Paso CAP 2024	El Paso RS 2017	El Paso DP 2024	El Paso Water Strategy 2021		
Honolulu, United States	Honolulu CAP 2020	Honolulu RS 2019	Honolulu WRMP 2019	Honolulu Water Shortage Plan 2022		
Houston, United States	Houston CAP 2020	Houston RS 2019	Houston DP 2019	Houston Water Conservation 2019	Houston Climate Impact 2020	
Los Angeles, United States	LA Sustainable City Plan 2019	LA RS 2018	LA RS 2018	LA DP 2020	LA Hazard Mitigation Plan 2018	
Portland, United States	Portland CAP 2022	Portland WRMP 2020	Portland 2023 DP Retrospective	Portland Seasonal DP 2024		
San Francisco, United States	SF CAP 2021	SF RS 2016	SF UWMP 2020	SF Hazards and Climate Resilience Plan 2020		
Oceania						
Melbourne, Australia	Melbourne CAP 2018	Melbourne RS 2016	Melbourne DP 2016			
Sydney, Australia	Sydney Environmental Strategy 2021	Sydney RS 2018	Sydney Water Strategy 2022	Sydney DP 2022		
Auckland, New Zealand	Auckland CAP 2020	Auckland Water Strategy 2022	Auckland Water Allocation 2012	Auckland DP 2023		
Christchurch, New Zealand	Christchurch CAP 2021	Christchurch RS 2015	Christchurch Water Strategy 2019	Christchurch Water Bylaw 2022		
Wellington, New Zealand	Wellington Zero Carbon Plan 2019	Wellington Zero Carbon Implementation 2020	Wellington 2017 RS	Wellington DP 2024		
Singapore, Singapore	Singapore 2018 RS	Singapore PUB Our Water Our Future 2020	Singapore PUB Sustainability 2023	Singapore PUB Innovation 2022		

4.3 Coding Framework and Data Analysis

The coding scheme used for this qualitative content analysis is both deductive, based on similar coding schemes used to analyse drought management within the literature (as shown in Table 4), and inductive, using the content of analysed plans themselves to fill gaps in the coding schemes from the literature (Berg-Schlosser & Meur, 2009; Rihoux & Ragin, 2009; Thomann & Maggetti, 2020). In other words, existing coding schemes were used to structure the coding scheme for this study, including some open codes which were identified and filled with justification from a wider variety of literature and from drought-related urban planning documents. This follows the approach used to develop coding schemes for city plans by Berke et al. (2015), Sullivan and White (2020), and Woodruff et al. (2022).

Table 4. Coding analyses for drought framing used within the literature, with objective and data source identified to demonstrate that these had indirect applicability to this study, thus necessitating development of a more tailored coding scheme.

Study	Objective	Data Source
Sullivan and White (2020)	Understanding how employees within US state agencies and city governments frame climate change	Content analysis of multiple climate change planning documents at the city and state levels
Cravens et al. (2021)	Understand and create a typology for the key factors for decision making in drought preparedness and response	10 in-depth case studies
Müller and Kruse (2021)	Investigate the modes of climatization that industries employ when discussing drought issues, and how this lends to their requests in drought response	Content analysis of published literature in sector journals from German policy fields
Omari Motsumi et al. (2023)	Understand the governance factors at play during Botswana's worst drought event on record	Key stakeholder interviews

Cravens et al. (2021) and Müller and Kruse (2021)'s coding schemes provided the bulk of inspiration for the coding scheme used in this analysis. Müller and Kruse (2021)'s organisation of codes under the framing analysis categories of "sense-making," "naming problems," and "naming solutions" was used to guide the overall structure of the coding scheme for this study, as shown in Figures 4 and 5.

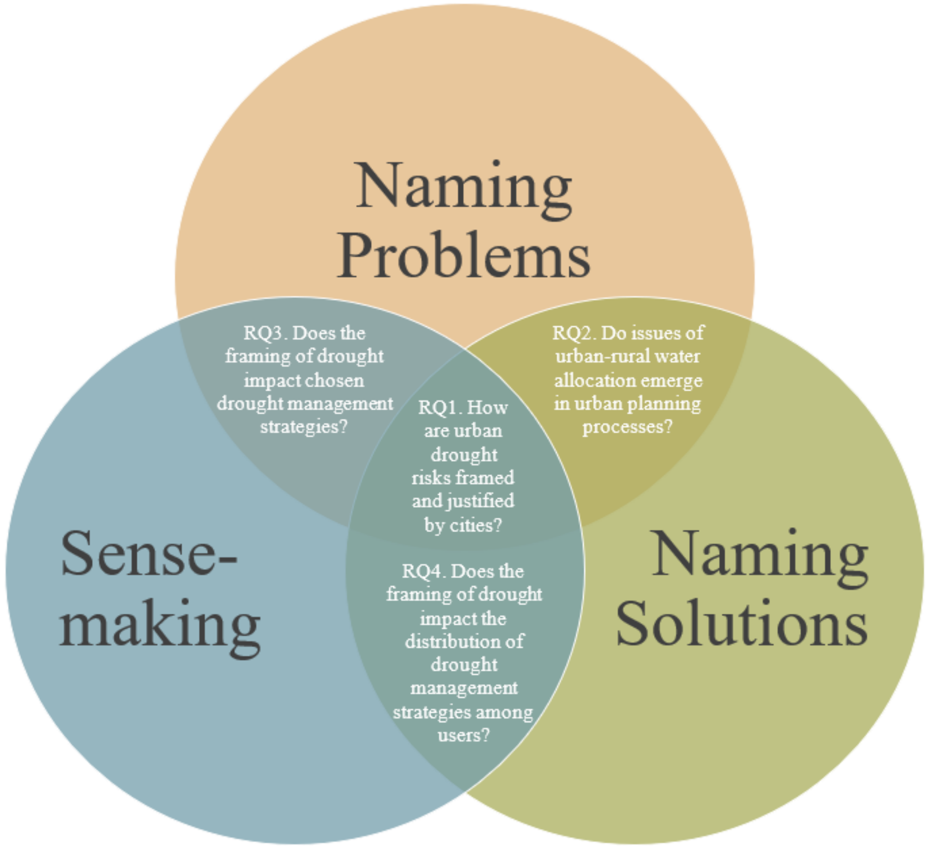

Figure 4. Nesting the research questions within the analytical conception for understanding the framing process from Müller and Kruse (2021).

Figure 4 demonstrates the connectivity of Müller and Kruse (2021)'s depiction of the framing process to the research questions, and demonstrates how the method of qualitative content analysis and this coding scheme serve to answer the research questions. Figure 5 shows how codes are nested within these frames of analysis, which is also reiterated in the simplified coding list of Figure 6 and in the coding table of Table 5.

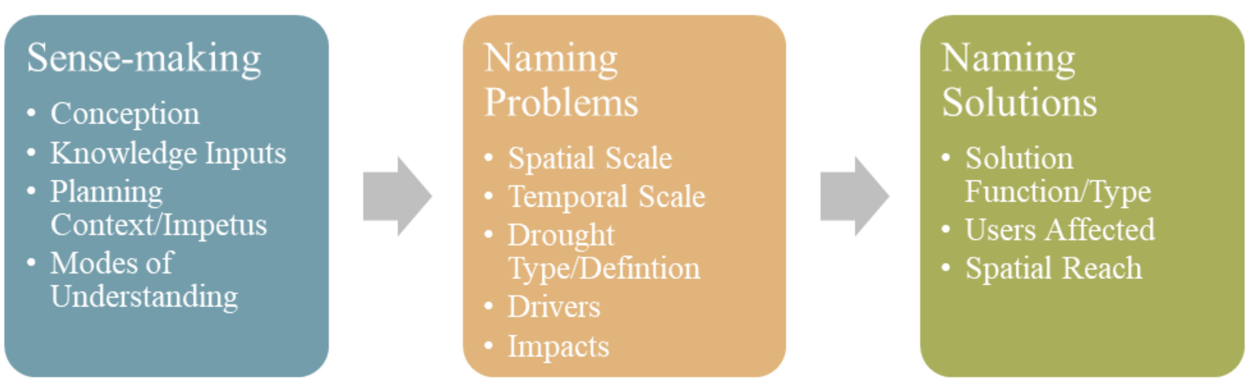

Figure 5. The organization of codes used in this analysis, as informed by Müller and Kruse's (2021) analysis of the framing of drought and climate change.

Codes were divided into sub-codes for further specificity, as shown in Figure 6 and Table 5. Alterations were made to the Cravens et al. (2021) typology for the framing of drought decision-making due to the more specific questions at hand in this analysis. For instance, the categories "drought issue focus" and "proactive vs. reactive" were removed, given that pre-planning for drought is the primary subject of study in this analysis, but was not the primary subject of their analysis. The category "decision context," from a different part of their typology, was incorporated into this coding scheme as "impetus". Table 5 further explicates, through colour coding, the literature that inspired the open codes, which were then filled inductively through content analysis of plans.

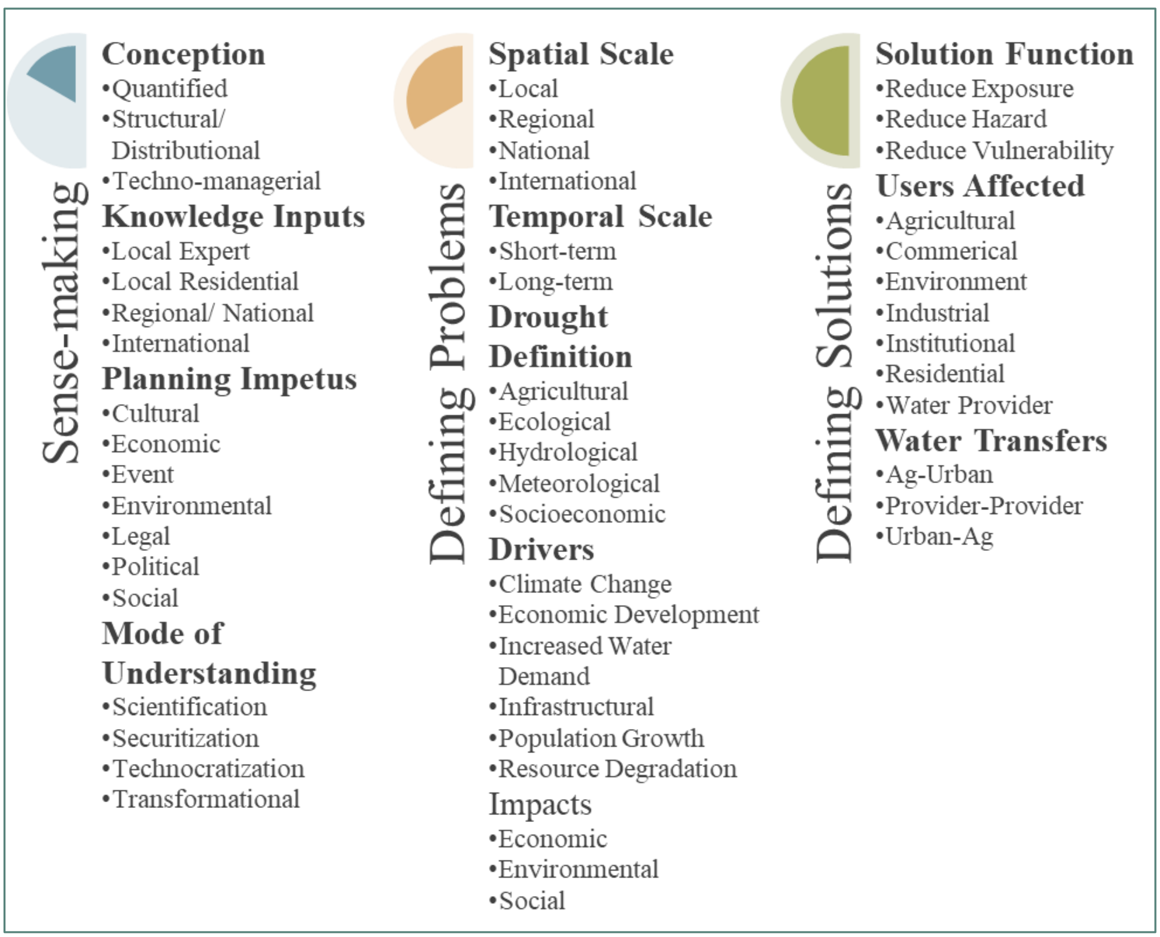

Figure 6. Simplified list of coding topics. Text was only coded at the lowest level (e.g., "structural/distributional" conception or "agricultural" users affects).

There are many ways to define and describe drought mitigation strategies, so many that creating descriptive typologies can be a task of unending specificity (Grecksch, 2018). An approach posited by Rijke et al. (2014) was selected as the means of dividing drought management strategies, as they speak to the proposed *function* of these various strategies in terms of reducing drought hazard, exposure, and vulnerability. These roughly fall roughly along the lines of water supply augmentation, increasing water efficiency, and reducing water demand, respectively. Although there are limits to this approach (Rijke et al., 2014), it is useful in this analysis as it relates to how the issue is framed.

Table 5. Code and sub-code table with definitions and examples. Text is color-coded to show the relationship between source and codes/sub-codes and provide proper attribution. Black text codes were created inductively through plan review.

	Code and Source	Sub-Codes	Definitions	Examples from Reviewed Plans
Sense-making (Müller and Kruse, 2021)	Conception (Huff & Mehta, 2019)	Quantified	The conception of drought is described according to terms related to a water balance, supply-demand balance, the likelihood of drought expressed as a ratio, or according to supply reliability standards	"At present, water supply is designed to withstand a 1:100 year drought. Climate change might increase the severity of a 1:100 year drought requiring the system to be redesigned to manage the change in conditions" ("Durban Municipal Adaptation Plans 2009", p. 15).
		Structural/Distributional	The conception of drought is described as arising or exacerbated due to the distribution of water or water infrastructure in the city	"The adaptation strategy involves actions to make Chennai resilient against floods and droughts, with a focus on their significant impact on vulnerable populations" ("Chennai CAP 2022", p. 50).
		Techno-managerial	The conception of drought is described as a threat to economic development or the prosperity of the city, and wherein the water provider operates according to cost efficiencies and investment priorities	"Water supports and sustains Greater Sydney as a highly successful global city, the nation's largest economic centre and the powerhouse of the Australian economy (contributing approximately a third of Australia's economic GDP). Over the last 20 years, Sydney has been in drought almost 50% of the time. To continue building a vibrant prosperous city, we must meet the city's needs both in and out of drought" ("Sydney DP 2020", p. 5).
	Knowledge Inputs (gap identified by Grecksch (2021) and typology informed inductively from plans)	Local Expert Knowledge	Knowledge generated by expert agencies at the city scale (additional to inputs from the main agency writing each plan)	"Stakeholder consultation. Consultations with key stakeholders from government agencies, NGOs, academic and research institutions has been a core element of action planning in Bangalore in order to reflect their vision and views" ("Bangalore Plan for Infrastructure 2014", p. 18).
		Local Residential Knowledge	Knowledge inputs generated by local residents/non-experts; community engagement process employed	"The Water Survey engaged more than 600 citizens from across the city including over 85 citizens from informal settlements and different socio-economic backgrounds" ("Chennai RS 2019", p. 44).
		Regional/National Expert Knowledge	Knowledge generated by levels of government above the city scale	"The U.S. Drought Monitor, which is used to understand general regional conditions and provides a reference for the city to support its review of other more localized indicators" ("Boulder DP 2022", p. 17).
		International Expert Knowledge	Knowledge generated by international bodies or datasets	"In 2015, the Water Resources Institute (WRI) ranked Singapore as one of the most water-stressed countries in the world. It thinks that, by 2040, Singapore would be one of eight countries in the world most vulnerable to disruptions in water supply" ("Singapore PUB Our Water Our Future 2020", p. 4).
	Planning Context or Impetus (category identified by Cravens et al., (2021) and further specified inductively from plans)	Cultural	Action is spurred by a culture recognizing the importance of wise water use, desire to create a culture of water conservation, or water provider leadership in water conservation	"Water is the basis of all life. It is not only essential for basic human needs, vital for productive and resilient natural ecosystems, and central to food, energy and economic security, it is also an important part of the spiritual, cultural and recreational life of communities. The strategy recognises that different people hold multiple and diverse views of water, and value it in different ways" ("Cape Town Water Strategy 2019", p. 15).
		Economic	Action is spurred by narratives of economic growth or preventing economic harm	"To meet the increasing water requirement, a significant amount of water is being transported from long distances... This incurs a huge financial cost and is also energy intensive as it requires a massive water supply and transport infrastructure. Therefore, the emphasis should be on the identification and assessment of potential water sources in nearby areas" ("Chennai Water Assessment 2021", p. 73).
		Event	Action is spurred or informed by past drought events	"This strategy was developed in the context of the severe three-year drought that Cape Town experienced from 2015 to 2017. Cape Town managed to get through it and avoid Day Zero by successfully reducing water use by more than 40%, which was a remarkable achievement. The lessons learnt in the process, what works well and what needs to be improved, have informed this strategy" ("Cape Town Water Strategy 2019", p. 6).
		Environmental	Action is spurred by the natural susceptibility of the city to drought conditions	"Contrary to its international reputation as a rainy city, London is prone to drought after only two dry winters" ("London RS 2020", p. 33).
		Legal	Action is spurred by legal requirements or legislative/regulatory requirements	"We, United Utilities Water Limited, have produced this final drought plan for the North West of England. Under section 39B(7) of the Water Industry Act 1991, water companies must prepare drought plans following consultation with regulators, and with customers and other interested parties (stakeholders), and make them available to the public. Our plan is based on current law and guidance, including the Water Industry Act 1991 and Defra's Drought Plan Guidance" ("Manchester DP 2022", p. 5).
		Political	Action is spurred by political considerations, such as the sharing of water between users or regional conflicts	"Water scarcity is amongst Jordan's most critical issues… Demand is also intensifying due to the increasing needs of those displaced by Syria's civil war. The population currently receive much less than the recommended WHO standard of 120 liters /person/day and this has been aggravated by the Syrian refugees" ("Amman RS 2017", p. 70).
		Social	Action is spurred by social causes, such as inequality or uneven water access and public health	"There are major disparities regarding access to potable water in the city. The Bengaluru Core area is generally well served, however, the villages have quite limited services and majority of households have recourse to the wells and collective water supply because of absence of water supply systems. It is imperative to improve access to potable water for households and improve the sanitary conditions" ("Bengaluru Water Supply Project 2017", p. 105).
	Modes of Understanding (Müller and Kruse, 2021)	Scientification	The problem is understood through scientific understanding and data, like hydrologic modelling, or necessitates more data or study to solve	"We have tested the effectiveness of our Drought Plan by simulating water resources conditions that are worse than any in the historical record, through the use of stochastically generated drought sequences. The assessment demonstrates that all six Water Resource Zones adhere to the effectiveness criteria. In all cases, the demand and supply options, as triggered by the protocols, introduced the appropriate measures sufficiently early to maximise their benefit and provide adequate lead times for subsequent more stringent measures, thereby averting Level 4 emergency measures" ("Thames Water DP 2022", p. 154).
		Securitization	The problem is understood through the lens of mitigating risk and reducing losses	"To be resilient in the face of multiyear drought and potential seismic activity, the City must reduce its reliance on imported water and meet local water goals by expanding groundwater sources, recycling water, and reusing stormwater" ("LA RS 2018", p. 56).
		Technocratization	The problem is understood to require technical interventions by experts/engineers and/or new innovations in decision support, technology, or approach, including deployment of "rainfall-independent supply"	"Actions in the Greater Sydney Water Strategy include moving towards an enduring supply (that is, increasing the amount of climate independent supply in the system), a strong water conservation program and short-term actions, such as changing the operation of the Sydney Desalination Plant, to increase our drought resilience and reduce the risk of being in severe water restrictions" ("Sydney Water Strategy 2022", p. 62).
		Transformation	The problem necessitates transformational change, understood as a type of system conversion or re-ordering of existing status quos	"The Urban Water Working Group, led by the Ministry for the Environment, developed five key principles that have also informed the strategy: (1) Papatūānuku – Our relationship with the land – papatūānuku – will pre-determine our relationship with water... (2) Ngā Wai Tuku Kiri – Our waters are a gift of life provided to us by our tupuna... (3) Tāngata – Our environments are places of human occupation... (4) Te Hāpori Me Te Wai – The community's love and care for water is enduring... (5) Tiakina Mō Apōpō – In building future resilience, our connectedness with the environment is our strength. Included within this principle is the need for improving community resilience and conserving our water resources" ("Christchurch Water Strategy 2019", p. 21).

Naming Problems (Müller and Kruse, 2021) and Drought Framing (Cravens et al., 2021)

Spatial Scale	Local	Problem defined solely by local implications	"The state has the authority to issue a drought declaration; however, a drought declaration does not necessarily mean that Portland's water supplies are affected. The bureau has not included a state-initiated drought declaration as a trigger for curtailment. However, to best inform its community following a state drought declaration, the bureau would assess whether to implement curtailment measures, given Portland's specific supply conditions" ("Portland WRMP 2020", p. 123).
	Regional	Problem defined according to reach beyond the city but not to national extent	"Projections indicate that Cape Town and the surrounding region, particularly the area where the primary dams are located, will experience a significantly drier climate in the future" ("Cape Town Climate Strategy 2021", p. 31).
	National	Problem defined up to national extent but not to international extent	"It is important to note that Amman's water supply is mostly sourced from water bodies outside of the municipal bounds. Therefore, water availability and pressures across Jordan have bearing on Amman's water quality and availability" ("Amman Green City Action Plan 2021", p. 128).
	International	Problem defined or associated with international extent/trends	"A large share of Johannesburg's water originates in the Lesotho Highlands Water Project. Hence, any changes in precipitation levels in the City of Johannesburg itself will have a relatively small impact on water security" ("Johannesburg CAP 2021", p. 106).
Temporal Scale	Short-term	Problem defined in terms less than one year or by seasonality rather than ongoing	"This Drought Contingency Plan describes the conditions that require short-term water demand management in the City of Dallas and establishes policies and procedures that offer strategies for a timely and effective response" ("Dallas DP 2019", p. 2).
	Long-term	Problem defined in terms greater than one year and is ongoing	"The Greater Sydney Water Strategy charts a direction for delivering sustainable and integrated water services to Greater Sydney for the next 20 to 40 years, servicing a growing Greater Sydney even through periods of severe and prolonged drought and other extreme events" ("Sydney Water Strategy 2022", p. 20).
Drought Type/Definition	Agricultural	The difference between plant water demand and available water, marked by soil moisture deficits which reduce agricultural productivity	"Soil moisture deficiencies relative to water demands of plant life, usually crops" ("Austin Hazard Mitigation Plan 2021", p. 59).
	Ecological	Threats posed by insufficient water availability to the health and integrity of ecosystems, biodiversity, and ecological processes	"In 2011/12 the Wessex area also experienced below average rainfall and low groundwater levels resulting in the threat of environmental effects" ("Bristol DP 2022", p. 24).
	Hydrological	Reduced surface water, snowpack, and groundwater availability	"During prolonged drought, reduced snowpack levels correlate to a diminished water supply for EBMUD customers" ("Berkeley RS 2016", p. 34).
	Meteorological	A prolonged period of abnormally low precipitation	"Exceptionally low amounts of rainfall in the region since 2007 have put increasing pressure on the city's water supply and recently caused Georgia's Environmental Protection Division to declare a Level 2 drought" ("Atlanta RS 2017", p. 14).
	Socioeconomic	The difference between water supply and demand	"The conventional municipal understanding of drought is focused on the relationship between municipal water supply and demand. From this perspective, the severity of a drought is measured by the margin of water available to meet demand" ("Calgary DP 2023, p. 12).
Drivers (category identified by Cravens et al., (2021) and further specified inductively from plans)	Climate Change	The cause of drought is related to climate change	"The impacts of climate change on our water will continue to grow. Water and climate change are inextricably linked. The impacts of a changing climate on water in Tāmaki Makaurau is already apparent. Variability in rainfall patterns already reduces Auckland's water supply and contributes to drought events" ("Auckland CAP 2020", p. 58).
	Economic Development and Urbanisation	The cause of drought is attributed to existing or future development, either economic and/or in increasing built area and building density	"The Pune water supply system is affected by many problems which are due to the fast and chaotic development of Pune and by the consequent need-based development of the water distribution network for keeping the pace of the water demand growth in various parts of the town" ("Pune Water Supply System 2014", p. 41).
	Increased Water Demand	The cause of drought is related to increasing water demands or increased consumptive water use	"High demands put increased pressure on water resources resulting in lower river and aquifer levels and an increase in use of stored water from the Macaskill lakes. This reduces drought resilience by reducing the volume of water available at the end of a dry summer when it is needed the most" ("Wellington DP 2024", p. 8).
	Infrastructural	The cause of drought is related to water supply infrastructure – insufficiency, aging, leaks, repairs, etc.	"The loss of water through leakages in a Victorian system exacerbate a drought situation" ("London DP 2020", p. 22).
	Population Growth	The cause of drought is related to urban population growth	"Calgary's continued growth adds additional drought-resilience challenges, as a finite quantity of water must be managed across more users" ("Calgary DP 2023", p. 11).
	Resource Degradation	The cause of drought is related to water resource degradation, including groundwater depletion, source overexploitation, pollution, siltation, saltwater intrusion, contamination, etc.	"Meanwhile, the availability and supply of water is decreasing from groundwater depletion, natural resource degradation and climate change" ("Addis Ababa CAP 2021", p. 110).
Impacts (category identified by Cravens et al., (2021) and further specified inductively from plans)	Social	The stated consequences of drought are social, such as public health and sanitation, or increased detriment to vulnerable populations	"In case of water scarcity and heat waves, households with limited access to piped water and vulnerable citizens (e.g., women and children) face socioeconomic inequities. In times of water cuts, for example, poor households are unlikely to be able to afford water tankers, adding to the burden of the crisis" ("Chennai CAP 2022", p. 50).
	Environmental	The stated consequences of drought are environmental, such as vegetation mortality or increased likelihood of wildfires	"Environmental losses are the result of damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation" ("LA Hazard Mitigation Plan 2018", p. 150).
	Economic	The state consequences of drought are economic, including agricultural losses, higher water prices, hydropower generation, and interruption of business activity	"The historical and potential impacts of drought on populations include agricultural and recreation/tourism sector job loss, secondary economic losses to local businesses and public recreational resources, increased cost to local and state government for large-scale water acquisition and delivery, and water rationing and water wells running dry for individuals and families" ("Boulder Hazard Mitigation Plan 2022", p. 250).

Naming Solutions (Müller and Kruse, 2021)	**Solution Function (Rijke et al., 2014)**	Reduce Drought Hazard	Increasing available water supplies, e.g. desalination, increased storage, reservoir management, inter-basin transfers; adjusting drought triggers	"Increase alternative water supply capacity by 2050 to meet 100% of escalated demand resulting from climate change impacts" ("Durban CAP 2019", p. 35).
		Reduce Drought Exposure	Increase the efficiency of existing water supplies, e.g. wastewater recycling, stormwater harvesting and reuse, household rainwater tanks, greywater recycling, sewer mining, leak reduction, infrastructure upgrades, water efficiency upgrades (building/plumbing), water efficiency upgrades (devices/fixtures), water conservation, water conservation rebates, water restrictions, improved irrigation practices, legislative and regulatory changes, educational/community outreach initiatives	"Unless otherwise stated in the declaration, all customers are requested to take the following voluntary water use restriction measures: (1) Check for and repair all leaks, dripping faucets, and running toilets; (2) Check for and correct excessive irrigation or uncorrected leaks that result in city water leaving the customer's property by drainage onto adjacent properties or public or private roadways or streets or gutters; and (3) Irrigate between 7:00 p.m. and 5:00 a.m. of the following day on no more than two days per week" ("Houston DP 2019", p. 10).
		Reduce Drought Vulnerability	Reduce water demand or improve water allocation, e.g. watershed management, temporary weirs, precautionary caps on rivers, environmental flow protections/releases, water metering, price/tariff adjustments, water markets, monitoring systems, water audits, drought-tolerant landscaping, legislative and regulatory changes, educational/community outreach initiatives	"Assess the resilience of specific climate-adapted tree species to extreme heat and drought by implementing and monitoring three pilot tree-planting projects, and use the outcomes of these pilots to inform the use of climate adapted species in future tree-planting projects" ("Vancouver CAP 2024", p. 31).
	Users Affected within Drought Solutions (typology informed inductively from plans)	Agricultural	Solutions to drought impact farmers, ranchers, agriculturalists, etc. and their land and businesses	"Boulder may evaluate municipal needs and projected supply and determine that its ability to lease surplus water to farmers is limited compared to normal years. It may thus reduce or curtail its leasing program to make the most of its supplies during a drought period" ("Boulder DP 2022", p. 12).
		Commercial	Solutions to drought impact businesses and their operations	"Primarily target commercial customers. The Drought Direction 2011 sets out the uses that can be banned including the use of mechanical vehicle washes, filling nondomestic swimming pools (exclusions include public pools) and using hosepipes to clean the exterior (including windows) of nondomestic buildings. We will apply all the discretionary concessional exceptions included in the UKWIR Code of Practice and Guidance for Water Companies on Water Use Restrictions (2013)" ("Manchester DP 2022", p. 26).
		Environment	Solutions to drought are employed to maintain minimum flows or impact nature, landscapes, parks, wildlife, ecosystems, etc.	"We have an obligation to protect waterway health and maintain minimum environmental flow rates. During drought and low flow conditions, licence holder's access to water will be rostered, restricted or banned depending on the flow levels within nominated waterways to avoid adverse environmental impacts and preserve minimum flows" ("Melbourne DP 2016", p. 9).
		Industrial	Solutions to drought impact industries and their operations	"As projected water demand growth is expected to be driven by the industrial sector, non-domestic water efficiencies must be improved through measures such as recycling water on-site for reuse to conserve our scarce water resources" ("Singapore PUB Sustainability Report 2023", p. 23).
		Institutional, Governmental, etc.	Solutions to drought impact the local government, agencies, water providers, schools, jails/prisons, etc.	"Government agencies and military users reduce their usage by 10% during Alert Water Shortage Conditions and 30% during Critical Water Shortage Conditions. Include applicable strategies and/or tactics and current usage in communication" ("Honolulu Water Shortage Plan 2022", p. 21).
		Residential	Solutions to drought impact residents and targets at the household level	"Primarily target domestic customers. Customers must not use hosepipes connected to the mains water supply to water gardens, wash cars, fill a domestic swimming pool, and similar uses" ("Manchester DP 2022", p. 26).
		Water Provider	Water provider has primary responsibility for the proposed drought solution action through its operations	"Water Utility Measures: increase public education and outreach regarding water use reduction; reduce landscape water consumption at all EPWater facilities by 10%; increase output by employing reserve wells, and maximizing reservoir holdings; cease routine line flushing and testing; cease routine fire hydrant flushing and testing; increase targeted outreach to high consumption ICI customers to urge water use reductions" ("El Paso DP 2024", p. 8).
	Water Transfers (Garrick et al. (2019) and Hooper (2015) and typology informed inductively from plans)	Agriculture – Urban	Water transfers or drought support from agriculture or farmers to the city/ water provider/ urban environment	"Acquisition of water rights from farmers or others for additional source water augmentation" ("El Paso DP 2024", p. 15).
		Provider – Provider	Water transfers from one water provider to another	"The Bay Area Regional Reliability (BARR) Shared Water Access Program. As part of the BARR Partnership, a consortium of 8 Bay Area water utilities (including ACWD, BAWSCA, CCWD, East Bay Municipal Utility District (EBMUD), Marin Municipal Water District (MMWD), SFPUC, Valley Water, and Zone 7 Water Agency) are exploring opportunities to move water across the region as efficiently as possible, particularly during times of drought and emergencies" ("SF UWMP 2020", p. 69).
		Urban - Agriculture	Water transfers or drought support from the city/ water provider/ urban environment to agriculture or farmer	"Implementation of measures to sustainably secure water resources for agricultural activities during periods of low rainfall or drought (whilst minimising use of poor-quality water for irrigation)." ("Addis Ababa CAP 2019, p. 98).

This coding scheme was designed to be comprehensive, and therefore not every code applies to every plan or every city under study (Sullivan et al., 2024). Only some codes may be present. Further, there is redundancy in the coding scheme to account for overlaps between frames and nuances in plans which may explain similar concepts but frame them differently. Finally, the codes and sub-codes are not exclusive; a city can use multiple means of sense-making and problem definition to inform its understanding of drought. It is relatively common, for instance, for cities to recognize all the Drought Types/Definitions, given the difficulty in accurately defining drought.

The coding scheme was applied through a close reading of each city plan and conducted using the NVivo qualitative analysis software, which allows for several analyses to be run on the coded text (QSR International Pty Ltd., 2012). Relevant content was coded when it appeared within discussions related to drought and/or water scarcity. For example, climate change impacts to the city may have been discussed throughout a plan but were only coded when related to drought or water scarcity. Repetitive content was not double-coded; for example, if the plan started with a summary of a goal such as "improve water access during drought," that specific statement was not coded again when repeated later in the document. Further, examples were not coded, such as if the plan included a case study from another city. To ensure accuracy of qualitative content analysis, inter-coded reliability (IRR) procedures were followed, in line with standard practice (Krippendorff, 2018; Sullivan & White, 2020; S. C. Woodruff et al., 2022); however, this was done with just one coder, wherein two rounds of coding were conducted with a month in between each, to mimic the effects of two coders. Codes that did not achieve an IRR of 0.7 or greater were then reconciled (McHugh, 2012). Finally, the content within each code was checked for final verification that text was accurately coded. Results were then derived both inductively from the coded content, and through employment of NVivo's various tools, including the prevalence of each code, word clouds to determine priorities and sub-themes within coded content, and cluster analysis to explore whether there were relationships between codes. These are further described as employed in the Results section.

4.4 Limitations

4.4.1 Limits to the Cohort of Cases

The biggest limitation on the cohort of cities chosen was that plans needed to be available in English. Due to the nature of the inquiry at hand—understanding drought framing—translation services were not employed, as that would have added another layer of meaning-making within the data analysis process which would not have been verified by each city. While membership in C40 and RCN aided in finding plans in English, as the networks provide translation services to their members, that did not always extend to other plan types. Thus, there is only representation of countries where English is the national language or used in professional settings. This also created limited geographic diversity, with cities in only ten countries represented. All continents are represented except for South America, although there is very limited coverage across Europe, Asia, and the Middle East.

In searching for plans online, a few trends emerged which further limited data collection. First was the prevalence of international aid organizations to focus on nationwide drought planning efforts in developing countries and the Global South. This seemed to provide less attention to the city level and indicated a predominance of resources going to national ministries. The next problem was the availability of online resources; several cities seem to have the relevant plans in place but that simply are not accessible online or not housed on international internet servers (i.e., firewalled outside of the original country). A Virtual Private Network (VPN) was used to try to circumvent this, which worked in some cases to gain access to plans but did not work in every case.

4.4.2 Limits to Content Analysis of Plans

City plan-making is just one phase of urban climate change adaptation; as such, plans often do not directly indicate what actions have actually been implemented in a community, signalling only what the community may want and what it plans to do (S. Woodruff et al., 2022). The gap between rhetoric and reality can be significant, especially when examining planning and policy documents without associated means to measure the implementation of those documents (Betsill & Bulkeley, 2007). As such, a limitation of this study and its methods are that it may not reflect actual practice within the city, if what has been planned has not actually been implemented. Relatedly, the additional processes of decision-making at play during acute drought events include intervention by actors and processes which are not part of the traditional planning process, as revealed by the literature review (Gómez Gómez & Pérez Blanco, 2012; Makaya et al., 2020; Raikes et al., 2019). Thus, this study does not account for processes outside of plan-making, although multiple processes have bearing on drought management in practice. Further, examining networks of plans entails multiple benefits, as identified above, but also carries the limitation that planning is inconsistent across communities, making direct comparison difficult (Berke et al., 2015). As such, it is not the intention of this study to compare cities or to dissect the quality of individual plans, but rather to identify emergent trends across cases through examining discrete plan networks. Finally, all knowledge can be contested and misconstrued, including modelled climate data which may predict drought risk. Cities are institutions which are capable of producing inaccurate data, or misconstruing data in order to promote certain water management paradigms or to not unnecessarily worry the public (Kaika, 2003). This study does not engage with the validity of particular data sources or forecasting models; thus, a limitation of this study is that how a city plans for drought is taken at face value, despite that the reality or lived experiences among residents related to water access could be very different than what is represented or accounted for by the city (McEvoy, 2015). Further, as noted by some cities, the plans in place are limited in their effectiveness to the extent that their predictions and drought triggers are accurate. Unforeseen drought severity can cause management problems or crisis situations despite the best-laid plans.

5 Results

This section describes the results of the content analysis of city plans according to each research question. For RQ1, the overall trend of the prevalence of codes is described for the whole cohort of cities studied, followed by a summary of drought framing utilised by each of the 30 cities. The drought framing descriptions for each city are supplemented by charts showing the prevalence of each code present in their network of plans, and descriptions focus on the codes that are present rather than absent, though notable gaps appear. In the results for RQ2, the nuances of urban-rural water allocation as described within the coded content are explained. The results for RQ3 employ similarity indices to determine the relationships between the three drought mitigation strategy codes (Reduce- Exposure, Reduce- Hazard, and Reduce- Vulnerability) to each code in the Sense-making and Naming the Problem categories, as well as describes the trends within the proposed drought mitigation strategies across all cities. RQ4 also employs similarity indices for the User categories to see if drought issue framing influences the distribution of responsibility among water users. Terms are capitalised when referring to coded instances; terms are lowercase when describing that code as a more general topic within the plans.

5.1 Results for RQ1: How are urban drought risks framed and justified by cities?

As a whole, the cities in this study make sense of drought largely through having experienced a major drought Event, and by employing Scientific, Securitization, or Technocratic modes of understanding (Figure 7). Cities overwhelmingly name the problem of drought according to escalated frequency and intensity under Climate Change (Figure 8). These cities primarily name water conservation (Reduce- Exposure) as their solution to drought (Figure 9).

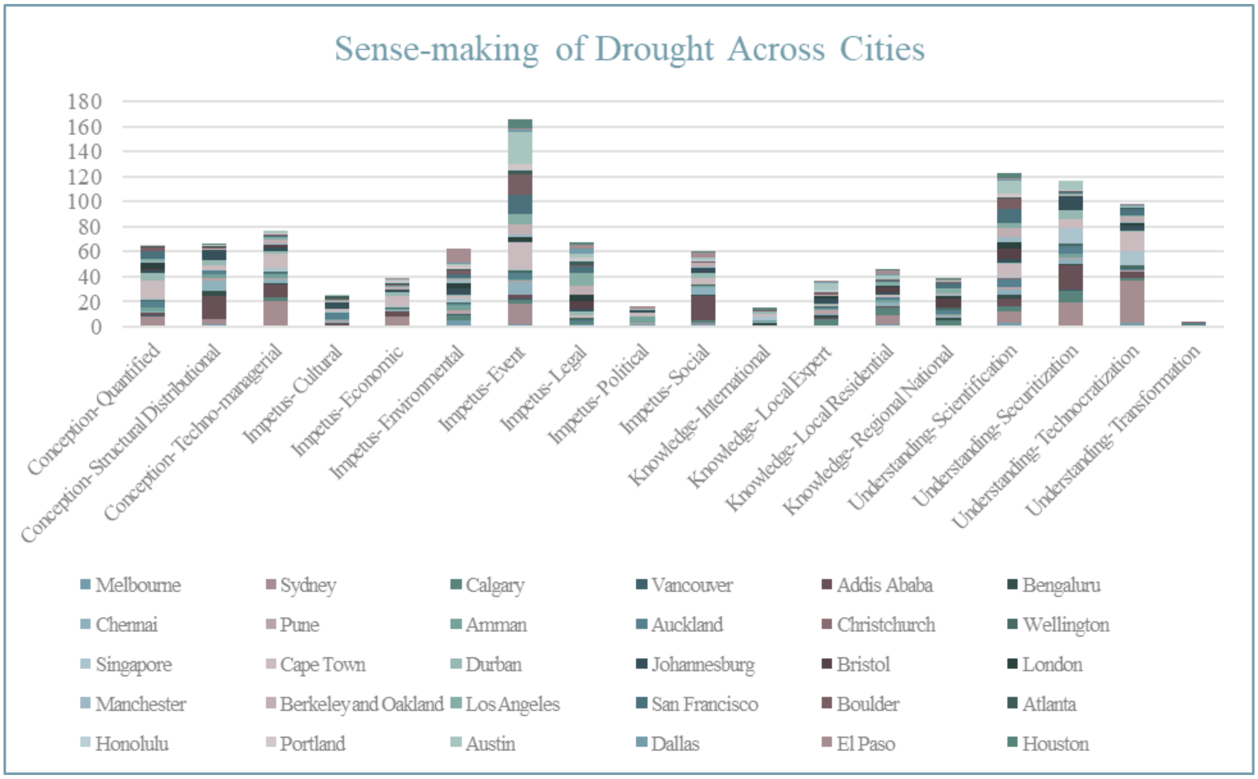

Figure 7. The number of instances each Sense-Making code was found across all city plans.

Experiencing a drought (Impetus- Event) was the primary way that cities made sense of drought at 166 instances (Figure 7). Cities that had experienced recent droughts referred to them often, and many described intentional lesson-learning during and after recent droughts. The most used category was Modes of Understanding—Scientification (123 instances), Securitization (117), and Technocratization (98)—apart from the Transformation code, which only appeared four times. The Conception categories were used less but relatively evenly among the three. The Impetus categories vary more widely, with experiencing drought Events followed by Legal (68), Environmental (62), and Social (60) impetuses for planning, and trailed by Economic (39), Cultural (26), and Political (16) reasons for drought planning. Finally, Knowledge Inputs were not widely acknowledged within the plans, explaining their relative underutilisation.

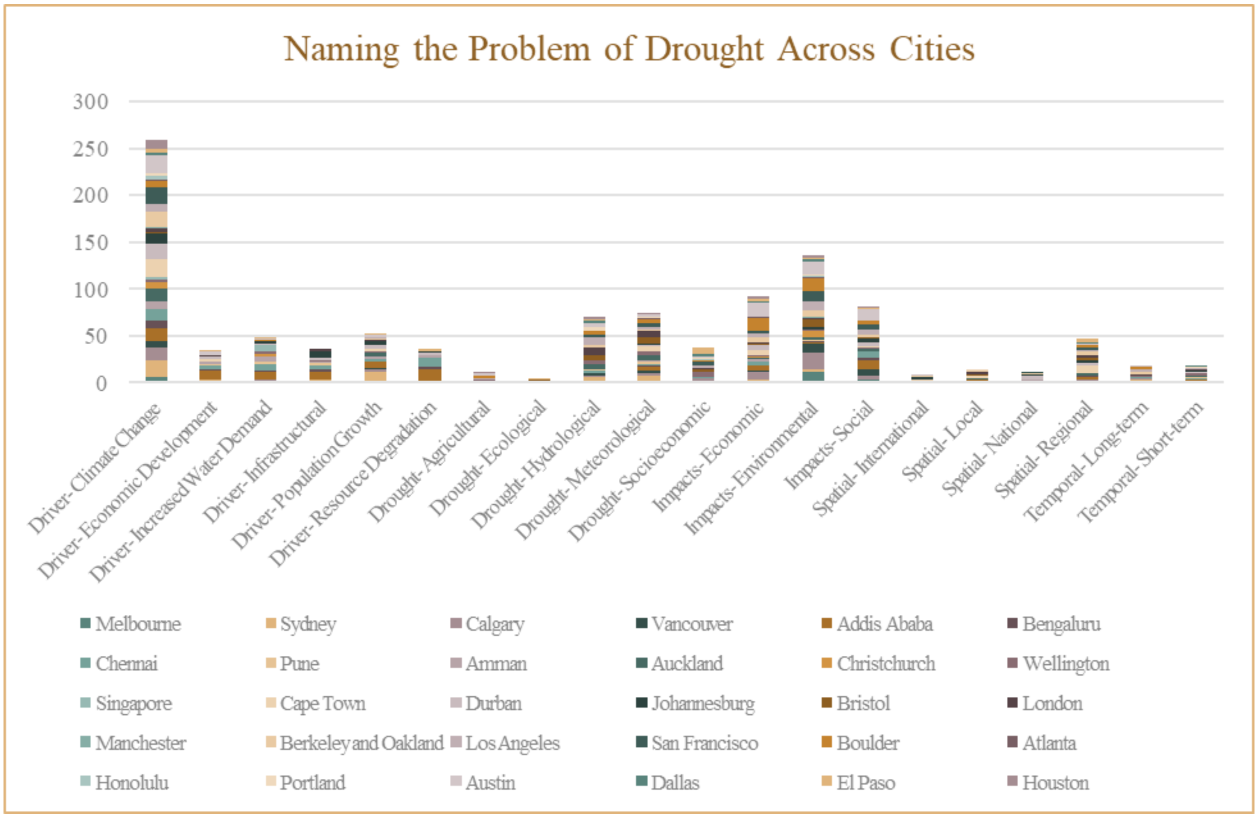

Figure 8. The number of instances each Naming the Problem code was found across all city plans.

By far, cities Name the Problem of drought by attributing it to Climate Change (259 instances) (Figure 8). Other Drivers trail far behind Climate Change. These cities also may acknowledge the definitions of drought, but the definition of drought does not factor majorly within their planning documents. It was common for a city to acknowledge and list several drought definitions, and then clarify that it did not use them in practice, but defined drought according to more specific indicators. The main drought Impacts that cities considered were Environmental (136 instances), though Economic (92) and Social (81) did not fall far behind. Finally, these cities often did not describe either the Spatial or Temporal scales of droughts, save to occasionally acknowledge Regional implications, particularly when the city's reservoirs or headwaters were outside of municipal bounds.

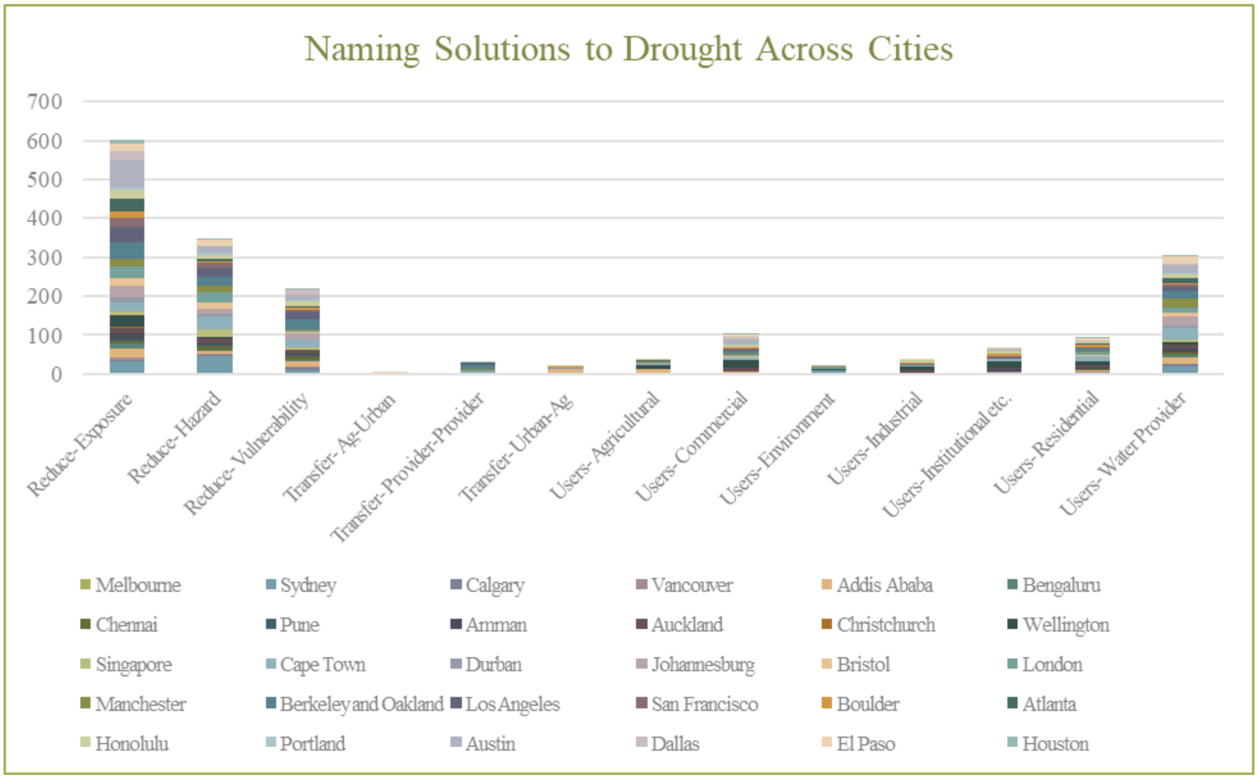

Figure 9. The number of instances each Naming Solutions code was found across all city plans.

These cities favour drought responses related to water conservation (Reduce- Exposure with 603 references) (Figure 9). Reduce- Hazard occurred 348 times and Reduce- Vulnerability occurred 217 times. The most common water Transfer described was between Water Providers, through emergency supply contracts or similar mechanisms. In naming solutions to drought, city plans did not well-define the target Users of their drought mitigation strategies, explaining low overall prevalence of these codes. Cities would refer to "all users" without describing the components of their user base (many cities do not have discreet agricultural users, for example) or would describe programmes like providing water-efficient fixtures without specifying the user class to which these are applicable. Despite this, plans did often describe the responsibility of the Water Provider itself during drought, which entailed actions such as system operational efficiency, pressure management, leakage reduction, and initiating water conservation campaigns, incentives, and surcharges.

5.1.1 Melbourne, Australia

Melbourne makes sense of drought, defines the problem of drought, and focuses its solutions to drought according to environmental needs. Its plans are very consistent in this sense; environment-related codes are the most prominent in each stage of analysis. Its Impetus for drought planning is Environmental (Figure 10), it is most concerned with the Environmental Impacts of drought (Figure 11), and its solutions focus on watershed management (Reduce- Vulnerability) and protecting minimum flows (Users- Environment) (Figure 12).

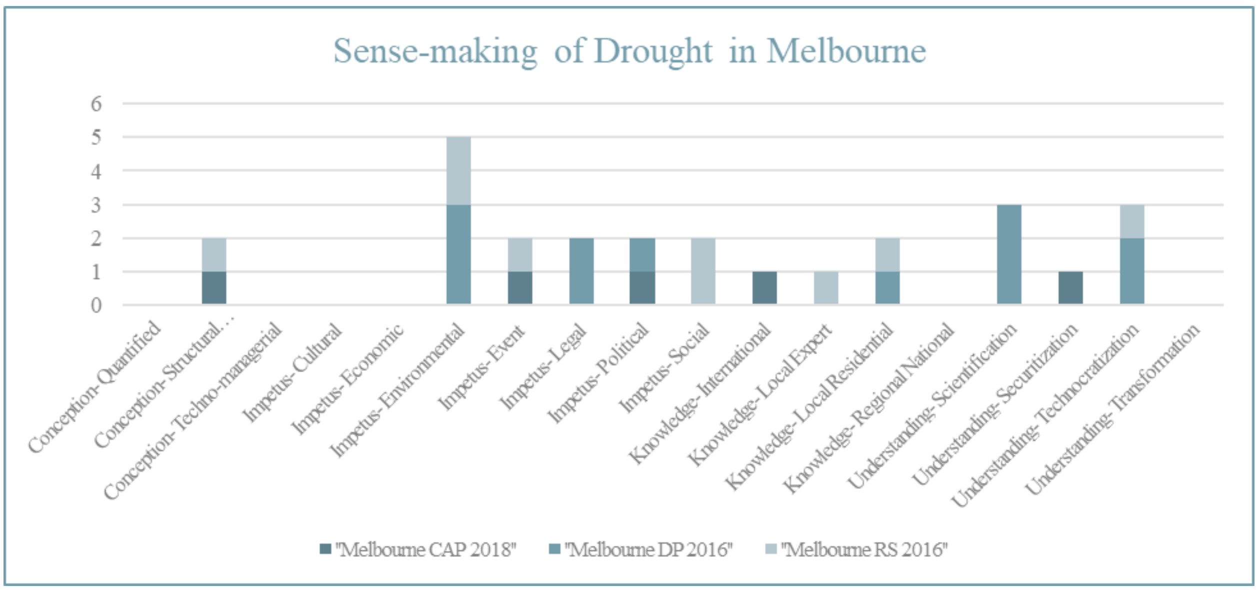

Figure 10. The number of instances each Sense-Making code was found within Melbourne's network of plans.

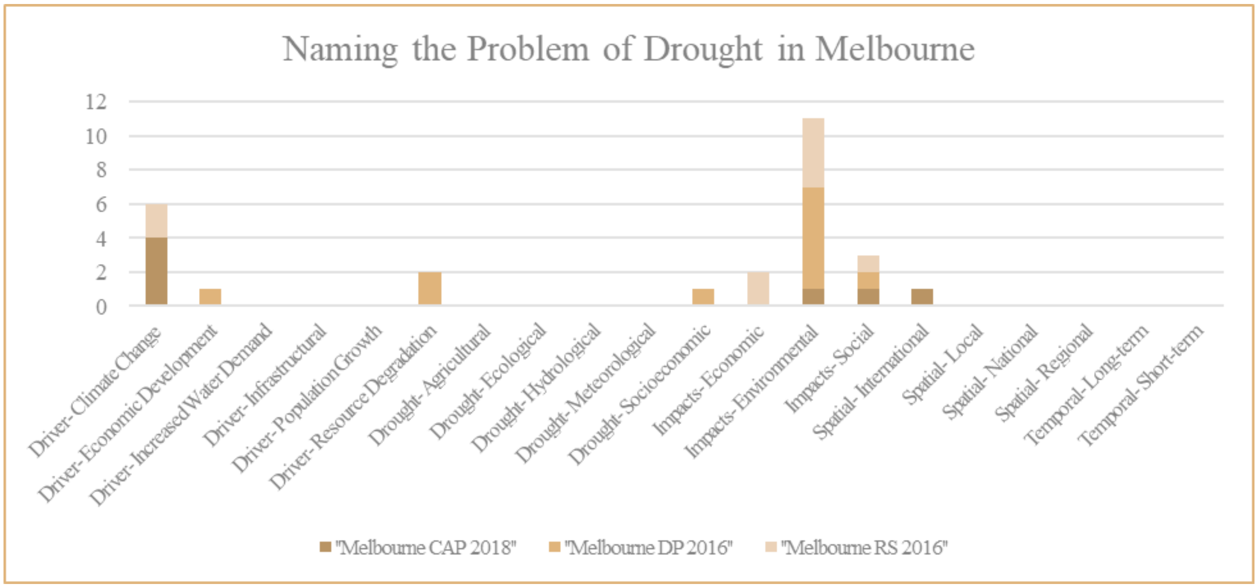

Figure 11. The number of instances each Naming the Problem code was found within Melbourne's network of plans.

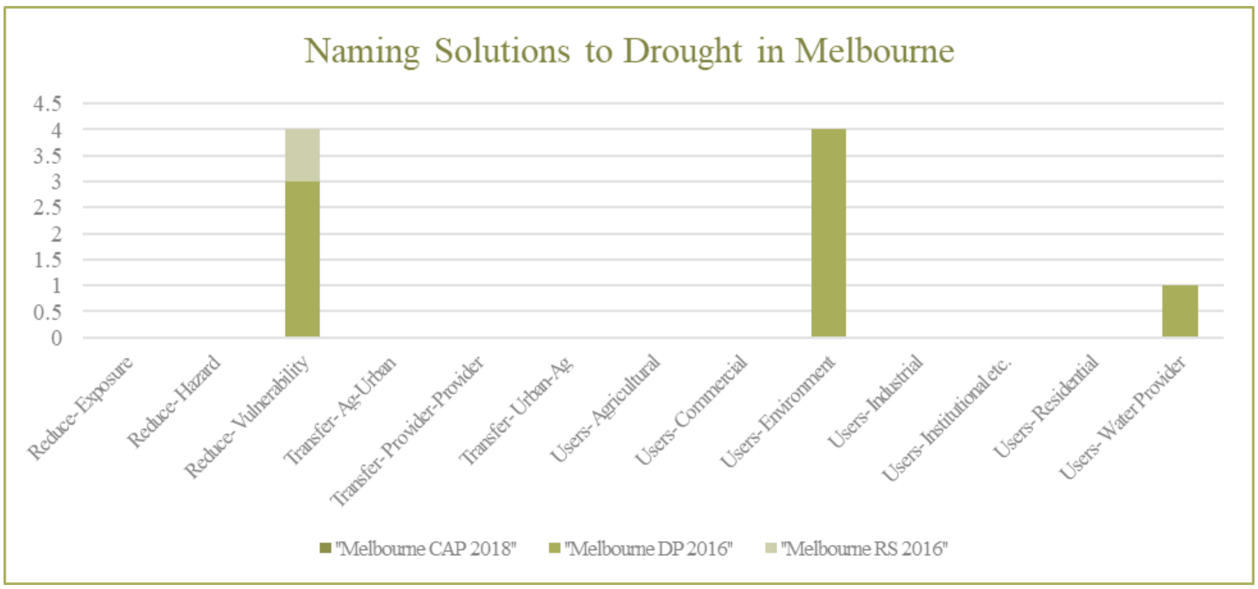

Figure 12. The number of instances each Naming Solutions code was found within Melbourne's network of plans.

5.1.2 Sydney, Australia

Sydney is working toward a "rainfall-independent supply" ("Sydney Water Strategy 2022", p. 62). Accordingly, Sydney makes sense of drought primarily through a Technocratization understanding (Figure 13), wherein technologies like desalination are needed to create a water supply which is separate from weather or climate systems. This is supported by a Techno-managerial conception, in which the motivation for rainfall-independent supply comes from a desire to support continued growth in the city; Securitization further reinforces this rhetoric. The City has one of the only instances of the Transformation code and has the only one that does not relate to integration of Indigenous perspectives; but rather, this coded text refers to Sydney's desire to change its previous approach to drought management via pursuit of rainfall-independent supplies. Sydney is simultaneously informed by its experience with the Millennium Drought (Impetus- Event) and driven by fear of similar droughts or worse spurred by Climate Change (Figure 14). Climate Change is the primary way it defines the problem of drought, along with Population Growth. Finally, with its focus on rainfall-independent supply, solutions to drought in Sydney focus on increasing water supplies through desalination (Reduce- Hazard) and wastewater reuse (Reduce-Exposure) (Figure 15). Its Water Provider has the main responsibility for enacting these.

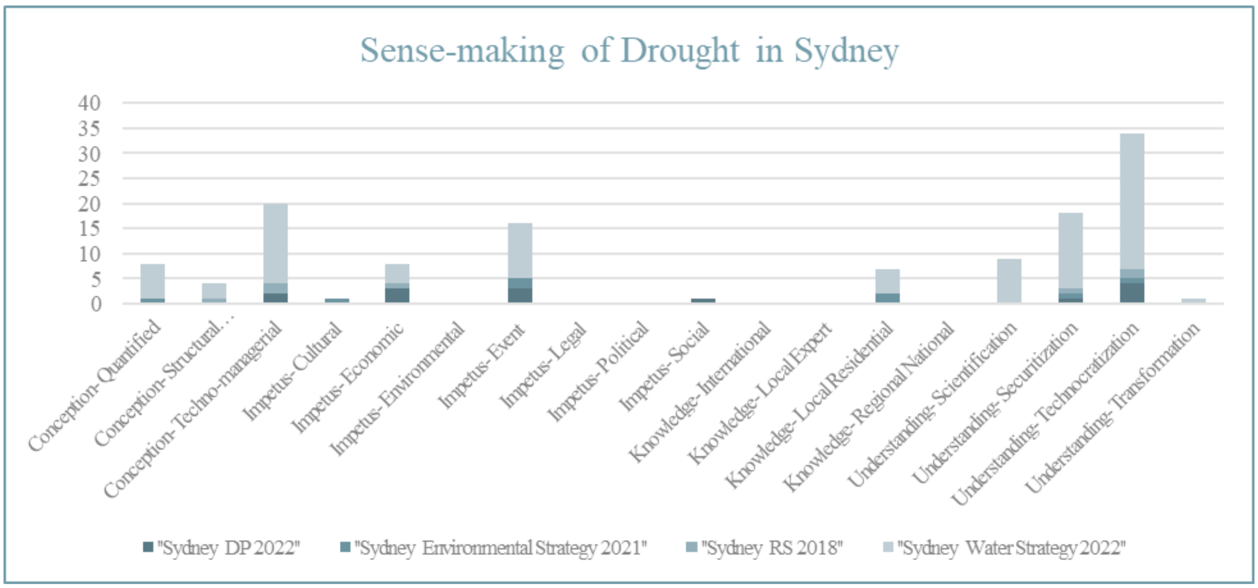

Figure 13. The number of instances each Sense-Making code was found within Sydney's network of plans.

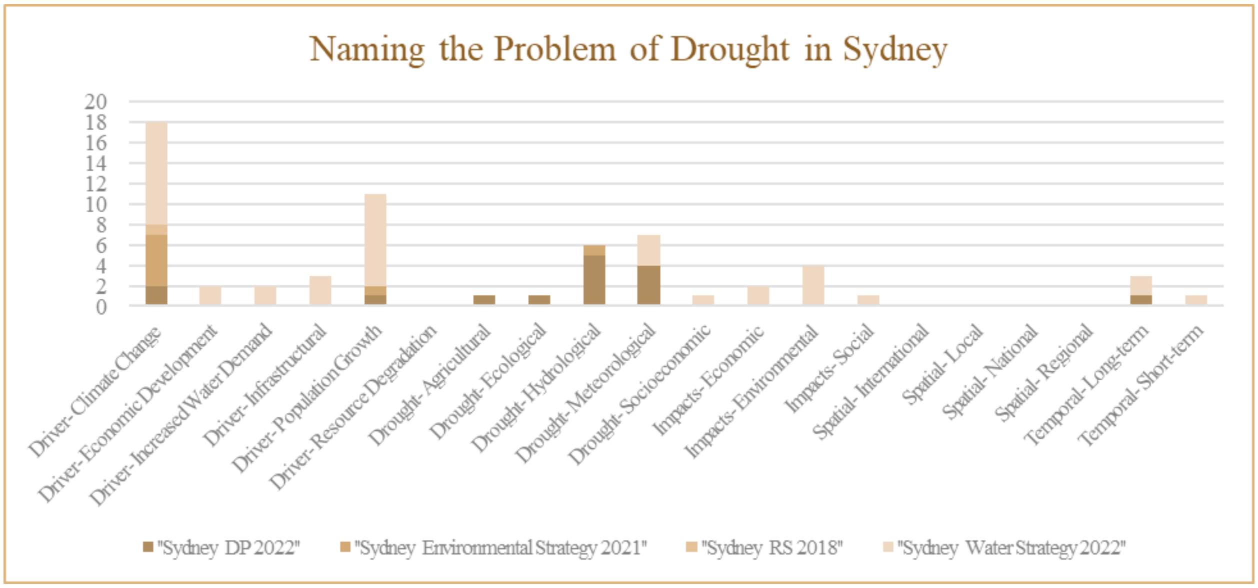

Figure 14. The number of instances each Naming the Problem code was found within Sydney's network of plans.

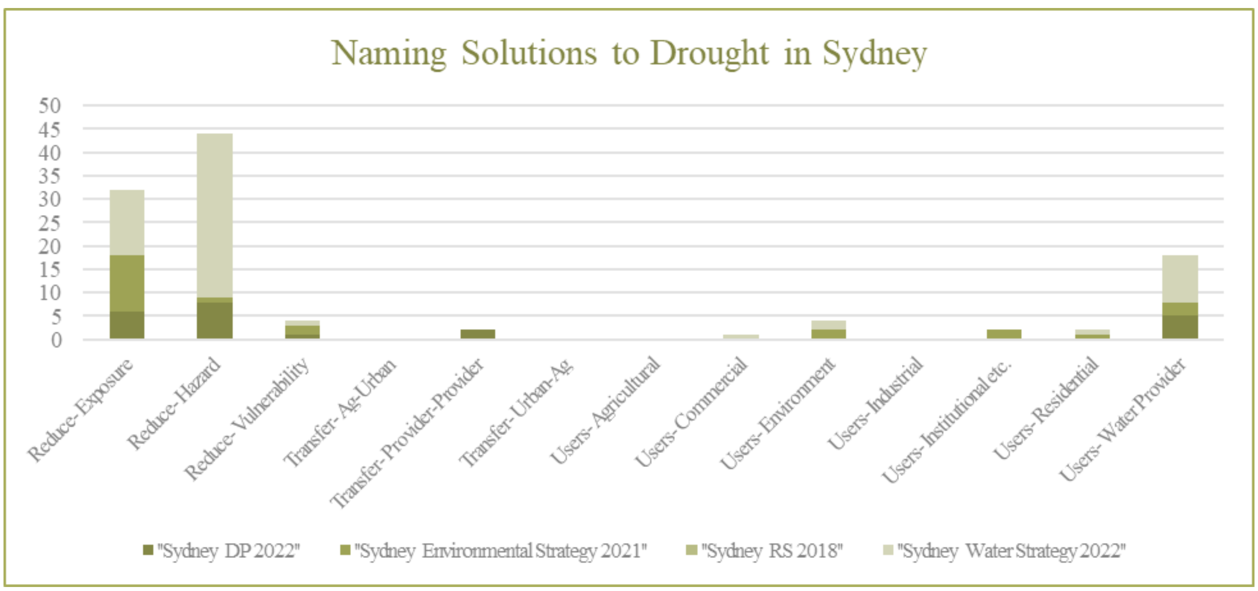

Figure 15. The number of instances each Naming Solutions code was found within Sydney's network of plans.

5.1.3 Calgary, Canada

Calgary makes sense of drought principally through a Securitization lens (Figure 16), as illustrated through this quote: "The City manages water security by having the right balance of activities across the connected levers of water supply, water demand and systems operations. Creation of the Drought Resilience Plan is a key action identified in this strategy" ("Calgary DP 2023", p. 12). The city has one of the few instances of a Transformative understanding of drought in this study cohort, informed by collaboration with the Indigenous Métis Nation. Climate Change and Impacts-Environmental are the key components of the drought problem for Calgary (Figure 17), particularly the connection between drought and source water quality. Calgary makes use of all three drought mitigation strategy categories, with the most coding falling into Reduce-Vulnerability, largely in connection to source water protection (Figure 18). Given the city's rather systemic approach to drought framing and solutions, the Water Provider has main responsibility for drought mitigation implementation.

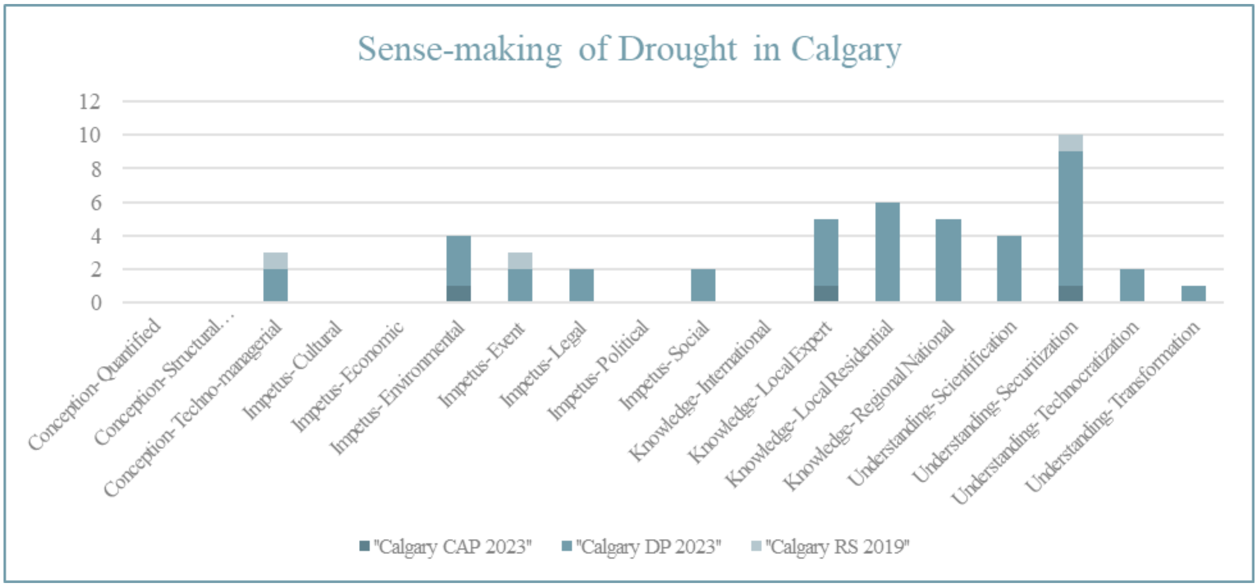

Figure 16. The number of instances each Sense-Making code was found within Calgary's network of plans.

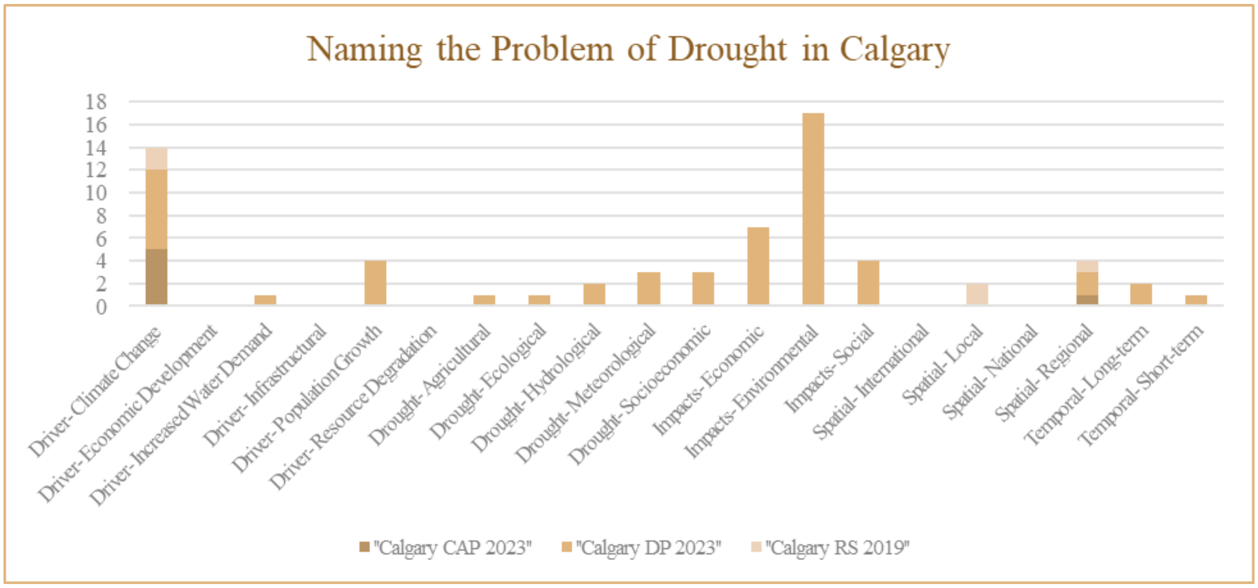

Figure 17. The number of instances each Naming the Problem code was found within Calgary's network of plans.

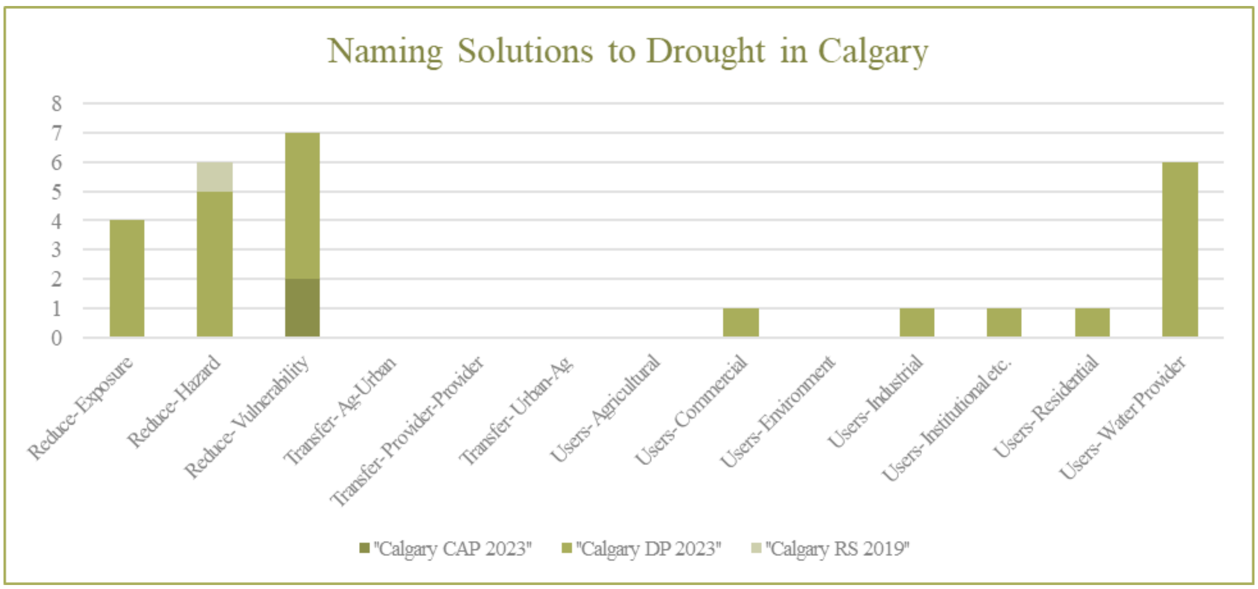

Figure 18. The number of instances each Naming Solutions code was found within Calgary's network of plans.

5.1.4 Vancouver, Canada

Vancouver is not very concerned with drought in the abstract, but rather more concerned about the acute experiences of drought. Each sense-making code that appears only appears once (Figure 19). In contrast, Vancouver names the problem of drought in terms of Environmental Impacts, Climate Change, and Social Impacts (Figure 20). Specifically, the city identifies the problem of drought as a confluence between extreme heat, lower streamflow, and wildfire ("Vancouver CAP 2024").

This corresponds to the city's proposed solutions being mainly in the Reduce- Exposure code, as Vancouver focuses on reducing peak summer demand through water conservation (Figure 21).

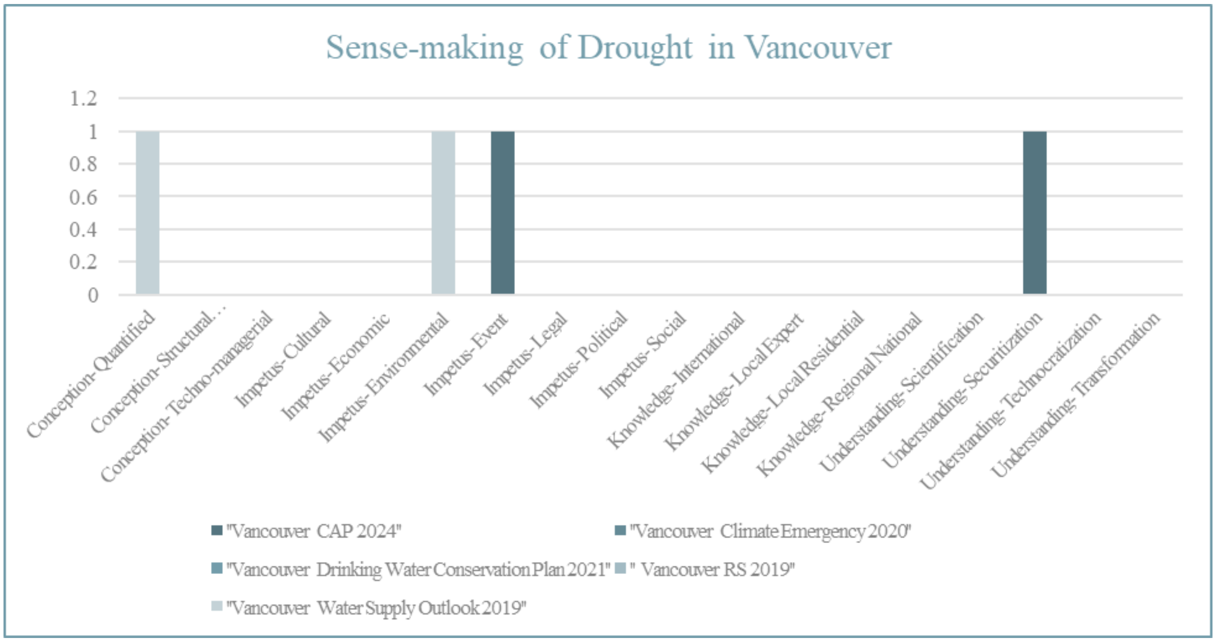

Figure 19. The number of instances each Sense-Making code was found within Vancouver's network of plans.

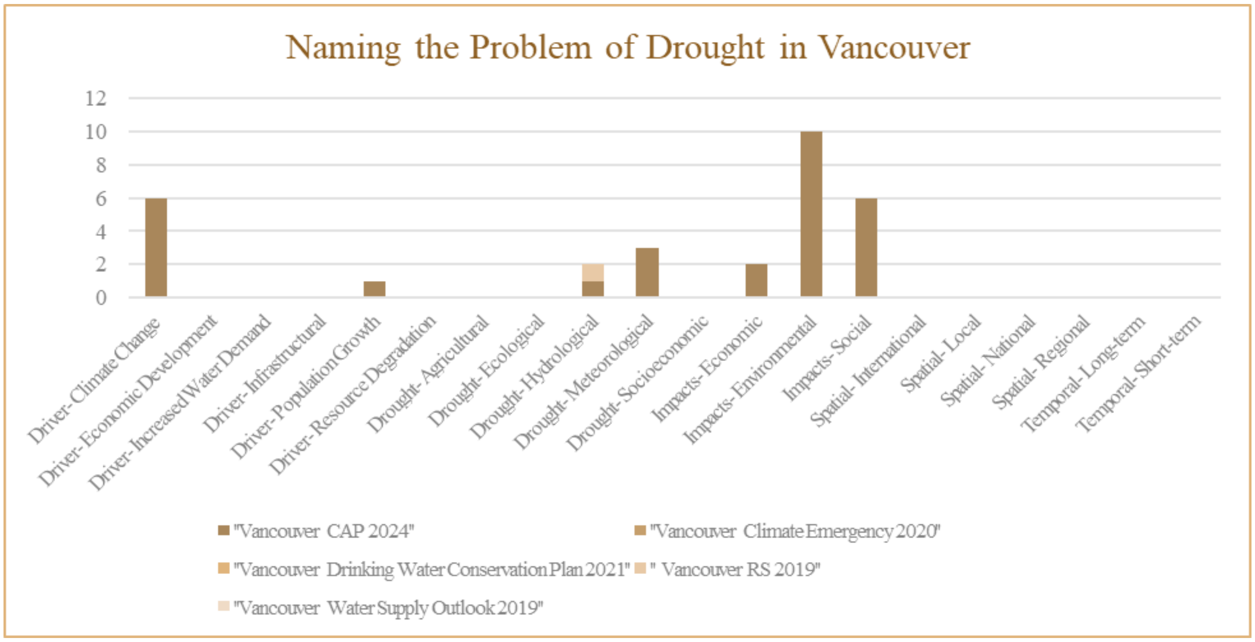

Figure 20. The number of instances each Naming the Problem code was found within Vancouver's network of plans.

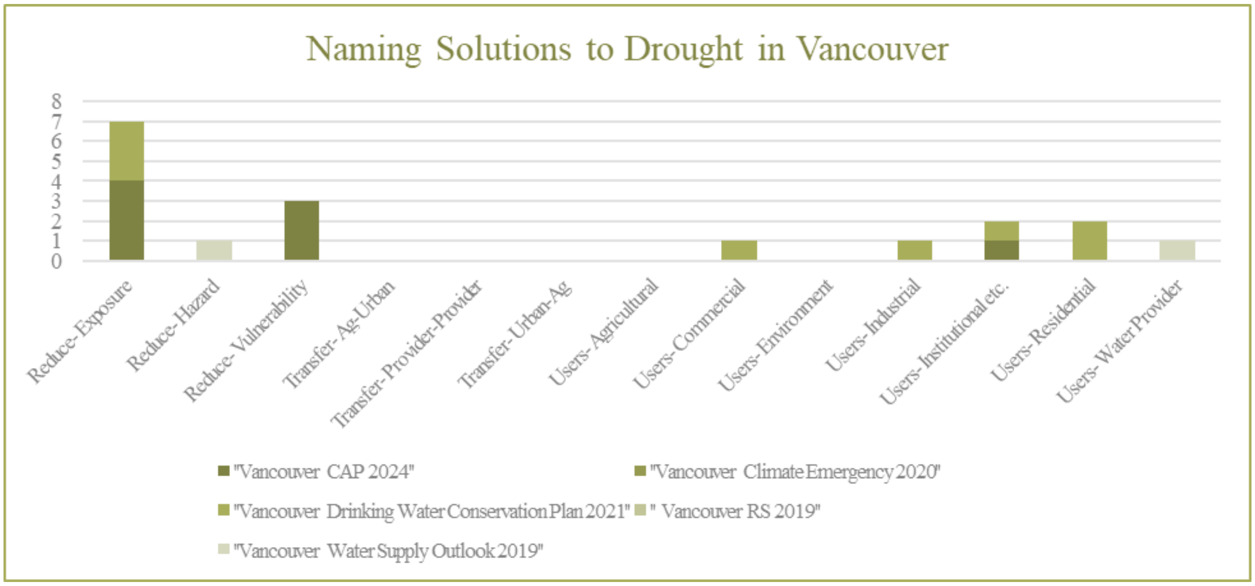

Figure 21. The number of instances each Naming Solutions code was found within Vancouver's network of plans.

5.1.5 Addis Ababa, Ethiopia

Addis Ababa is a city that is currently struggling to provide water in line with its urban demands. There is vast inequality of water access across the city, with low-income individuals experiencing intermittent water supplies as well as needing to collect water from public access points or hire from water haulers. As such, the city makes sense of drought according to a Structural/Distributional conception, Social Impetus, and a Securitization understanding (Figure 22). Addis Ababa is unique in this cohort of cities in naming the problem of drought through all Drivers with relatively similar occurrence (Figure 23), though Climate Change and Resource Degradation occur most often. There is also much recognition of the Social Impacts of drought, often according to public health concerns. Addis Ababa generally has holistic identification of drought problems. In connection with the noted social disparities in the city, the main solution for drought in Addis Ababa is to Reduce- Exposure, with a focus on curbing the water use of its highest users and reducing water leakages (Figure 24). The Water Provider takes most responsibility for these actions, in part because high-water users are unspecified within Addis Ababa's network of plans. Reduce- Vulnerability features prominently, through a focus on drought-tolerant landscaping and watershed management. Finally, Addis Ababa features several Transfer- Urban-Ag solutions because it is particularly concerned with the viability of small-scale agriculture and proposes programmes to support and proliferate drought-tolerant urban farming throughout the city ("Addis Ababa CAP 2021").

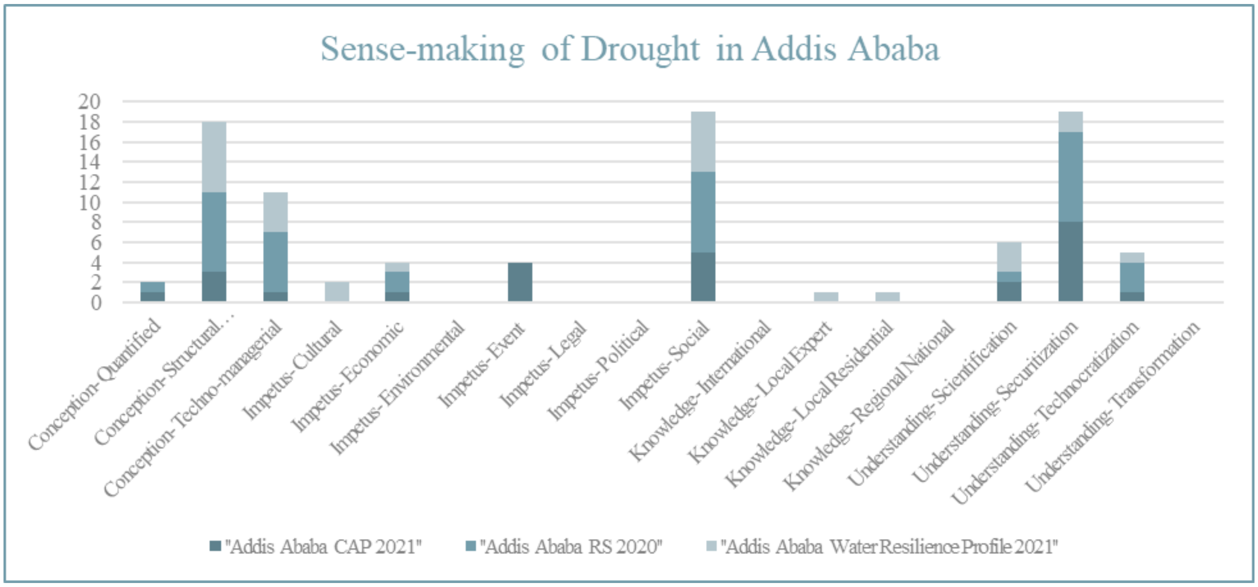

Figure 22. The number of instances each Sense-Making code was found within Addis Ababa's network of plans.

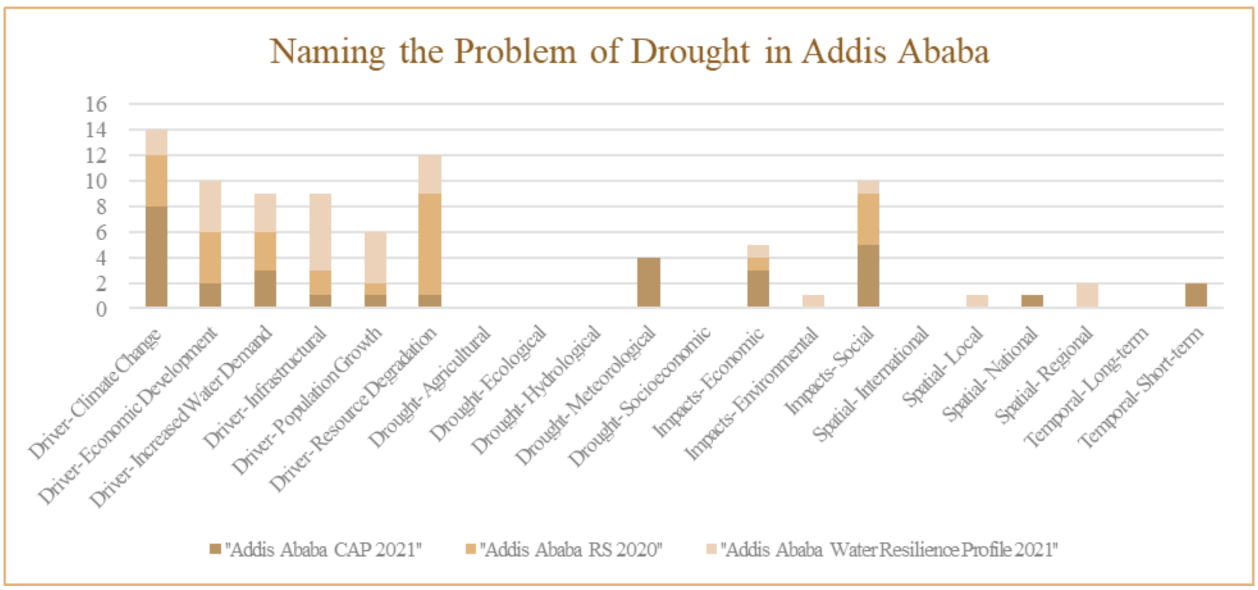

Figure 23. The number of instances each Naming the Problem code was found within Addis Ababa's network of plans.

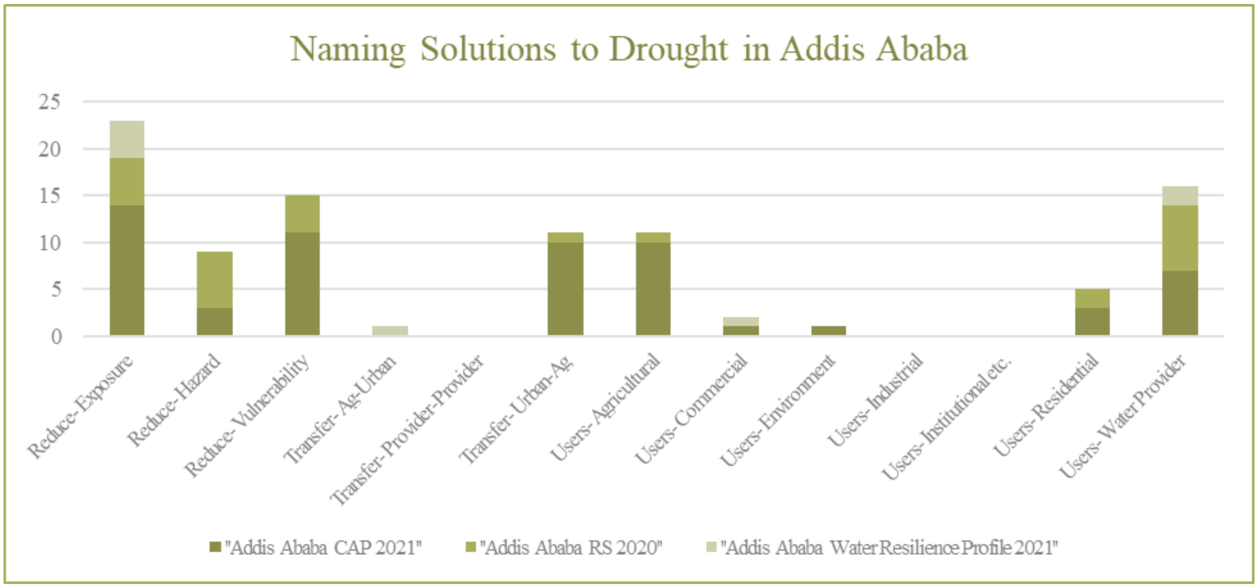

Figure 24. The number of instances each Naming Solutions code was found within Addis Ababa's network of plans.

5.1.6 Bengaluru, India

Bengaluru made sense of drought through a Structural/Distributional conception, noting that drought is a problem in the city due to uneven water access (Figure 25). Climate change is recognized as the primary driver of future droughts in Bengaluru, though other drivers are noted at least once (Figure 26). Bengaluru's priority is in reducing water leakages and promoting rainwater capture and wastewater reuse, falling mainly under the Reduce- Exposure code and implicating the Water Provider as responsible for these actions (Figure 27).

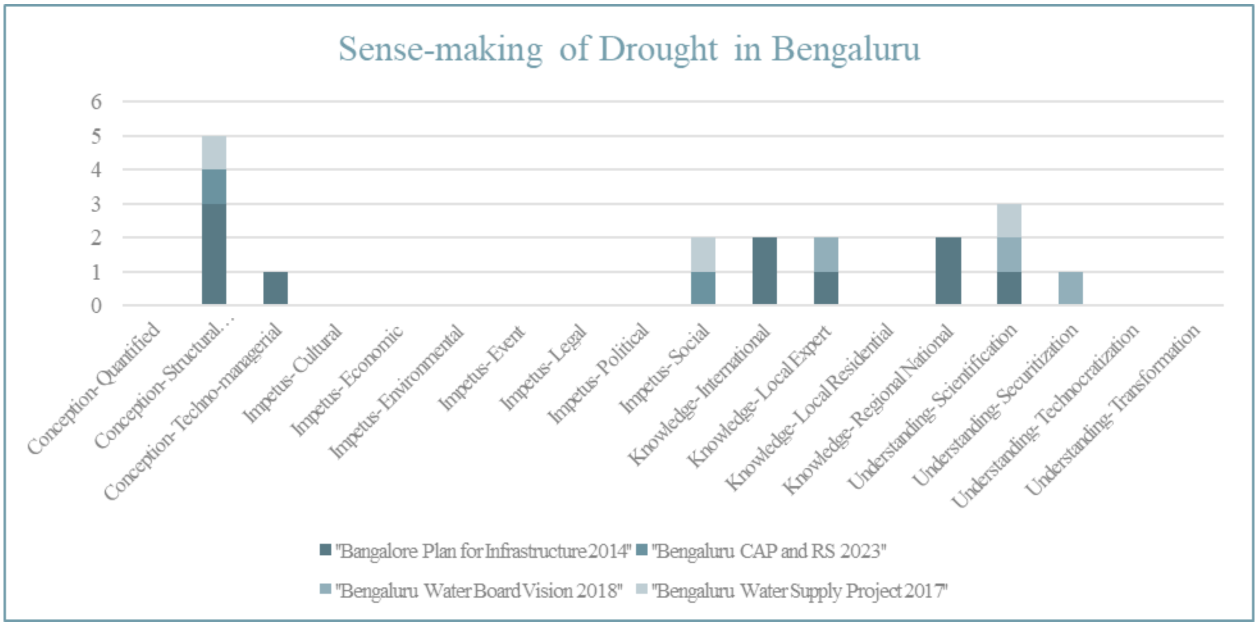

Figure 25. The number of instances each Sense-making code was found within Bengaluru's network of plans.

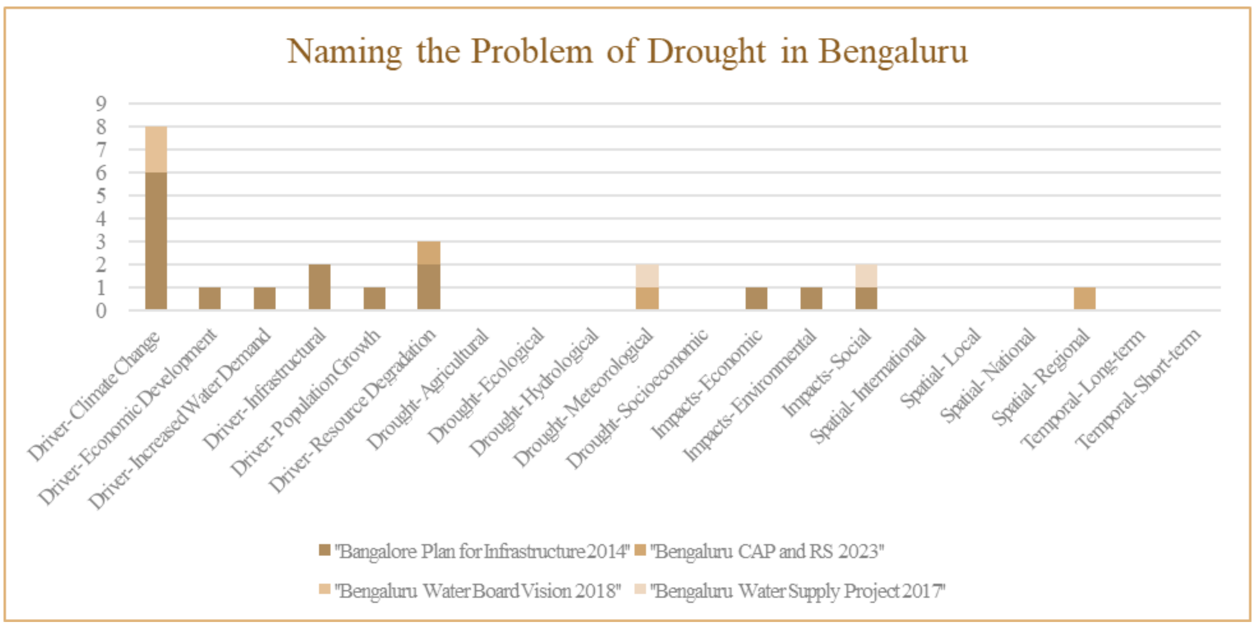

Figure 26. The number of instances each Naming the Problem code was found within Bengaluru's network of plans.

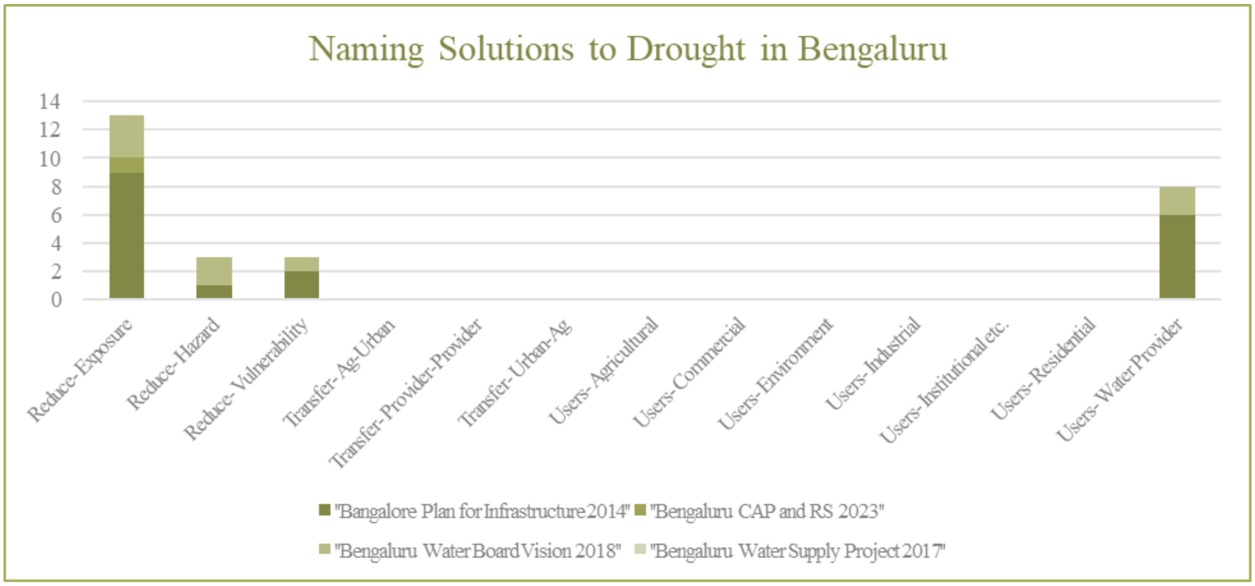

Figure 27. The number of instances each Naming Solutions code was found within Bengaluru's network of plans.

5.1.7 Chennai, India

Chennai made sense of drought through its experience with its own Day Zero event: "Post the 2015 floods, the city experienced a deficit monsoon for the ensuing three years, leading to Chennai facing "Day Zero" in 2019 when all its four water reservoirs went dry" ("Chennai CAP 2022", p. 92). The city has noted disparities in water access across its population, lending to the prevalence of the Structural/Distributional and Impetus- Social codes (Figure 28). Like many, Chennai names the problem of drought through Climate Change as a driver, followed by Resource Degradation primarily caused by overexploitation of surface water and seawater intrusion into groundwater (Figure 29). Reduce- Vulnerability is the most-occurring solution code, wherein Chennai focuses on water metering and pricing, followed by Reduce- Exposure and Reduce- Hazard which both cover the gambit of possible drought mitigation strategies (Figure 30).

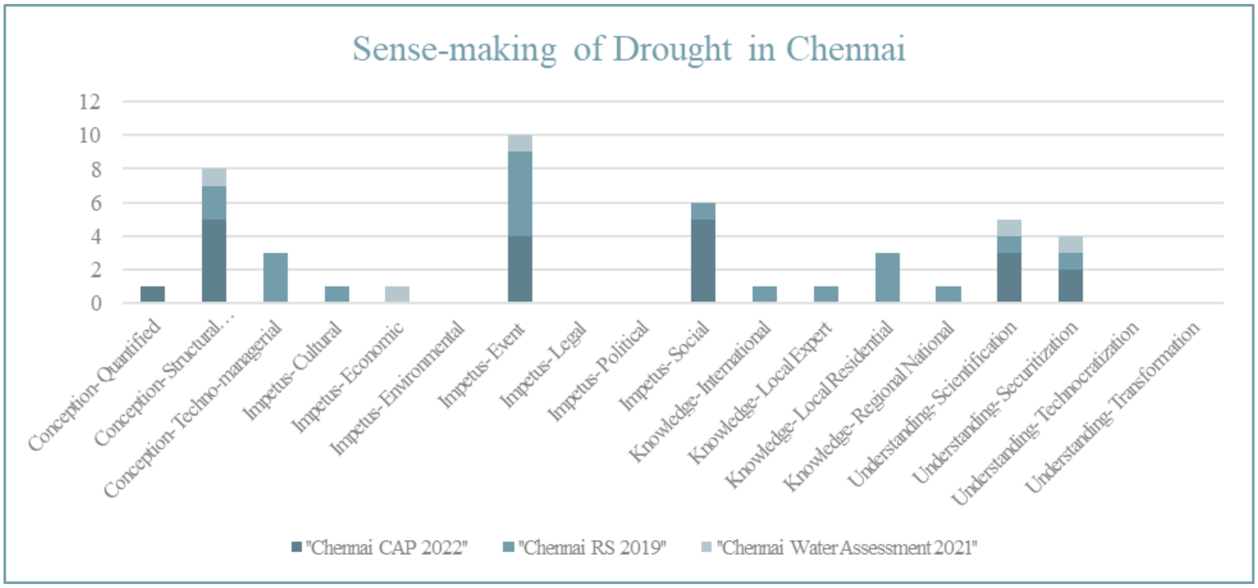

Figure 28. The number of instances each Sense-Making code was found within Chennai's network of plans.

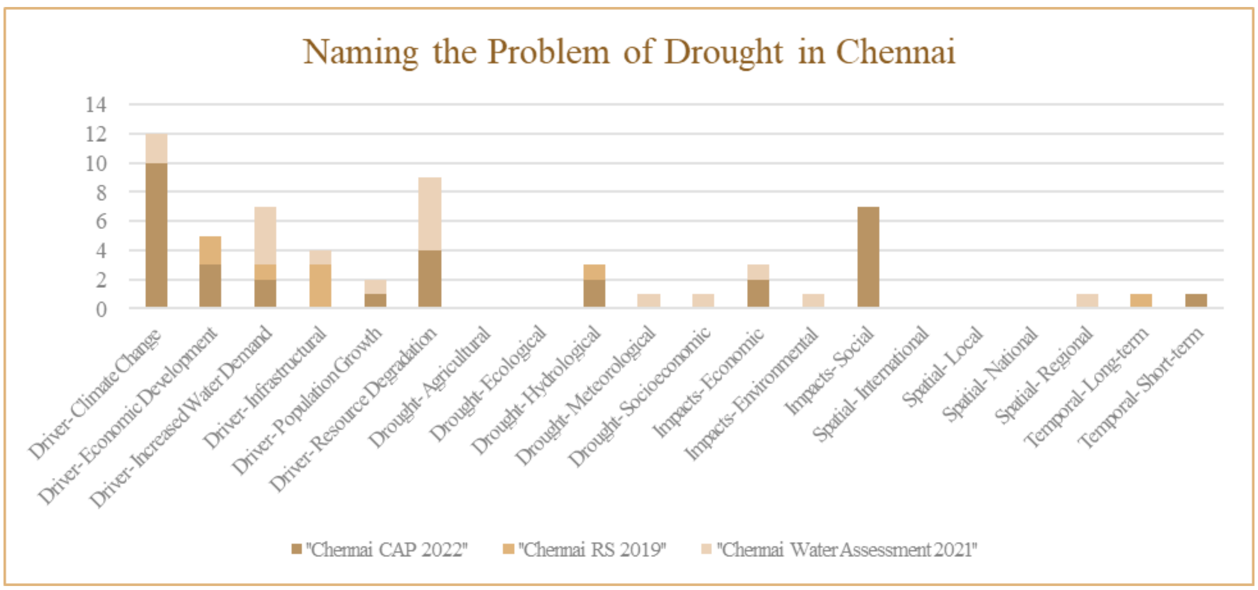

Figure 29. The number of instances each Naming the Problem code was found within Chennai's network of plans.

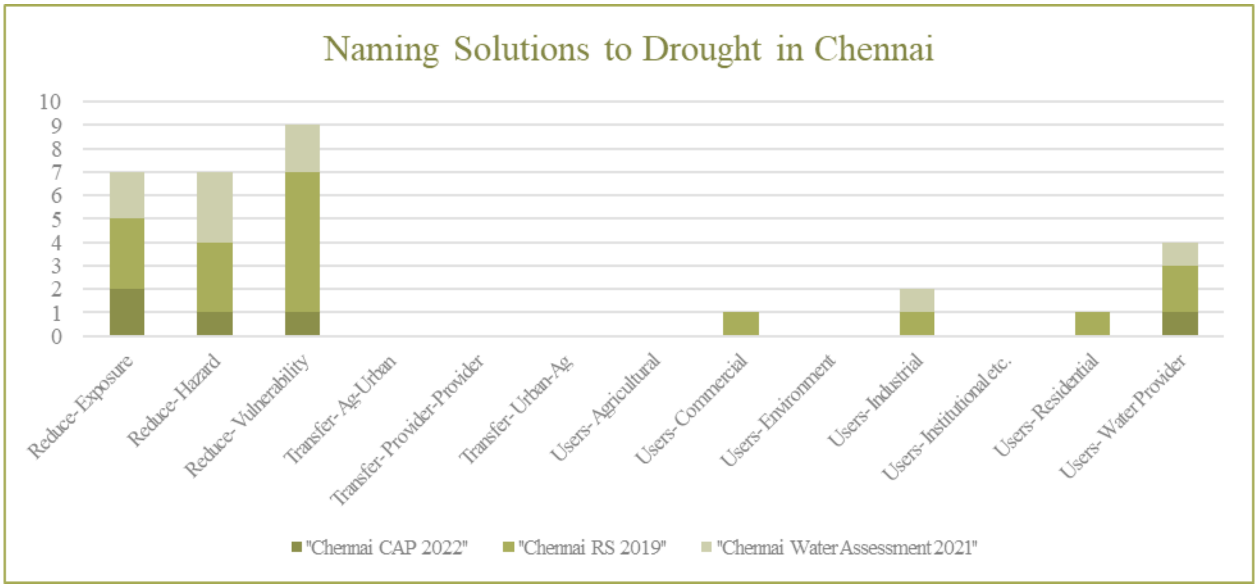

Figure 30. The number of instances each Naming Solutions code was found within Chennai's network of plans.

5.1.8 Pune, India

Pune is the least-coded city overall. Pune has low occurrence of several of the sense-making codes (Figure 31), naming the problem codes (Figure 32), and naming solutions codes (Figure 33), making it difficult to draw conclusions about the dominant framing. The coded content itself focused on groundwater management, supporting the development of drought-tolerant crops, metering, and infrastructural insufficiency.

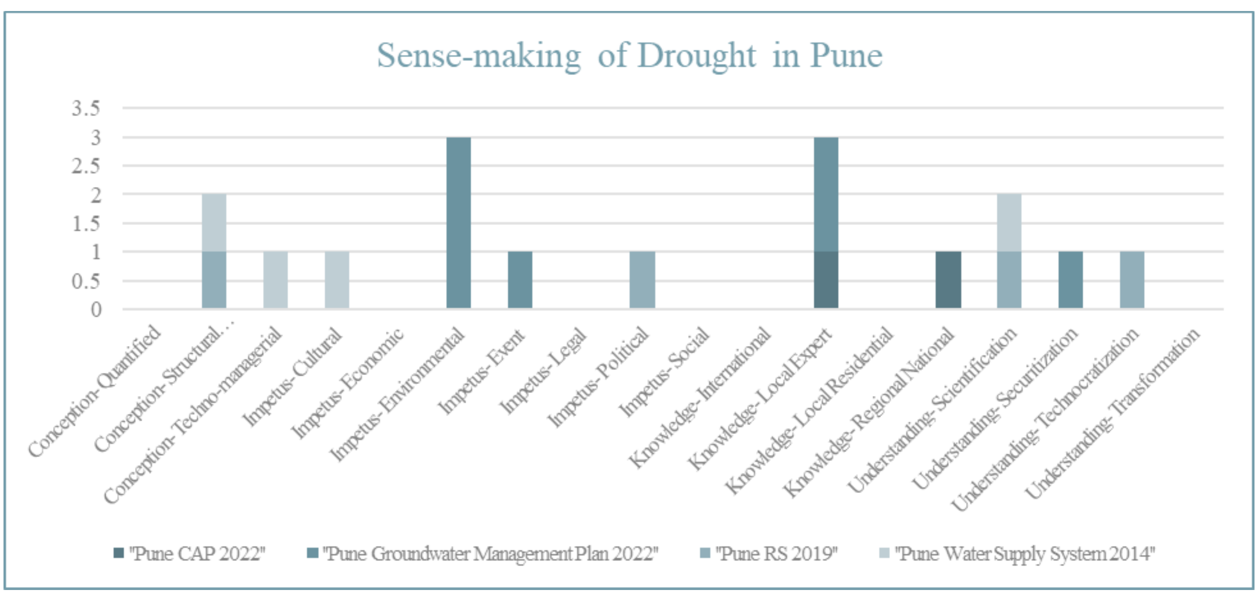

Figure 31. The number of instances each Sense-Making code was found within Pune's network of plans.

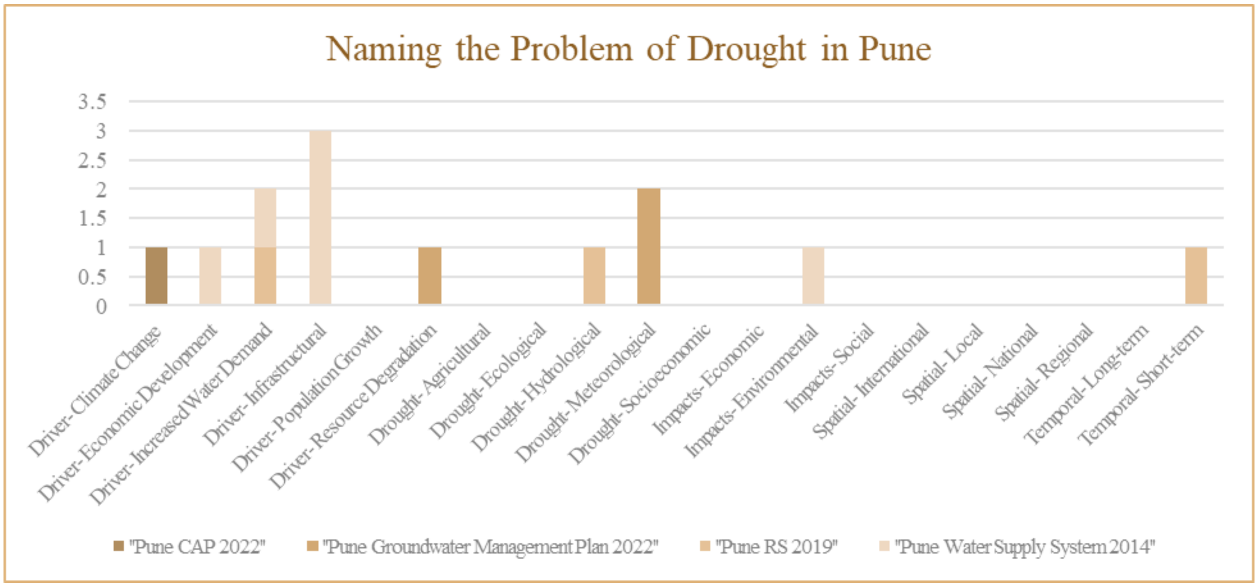

Figure 32. The number of instances each Naming the Problem code was found within Pune's network of plans.

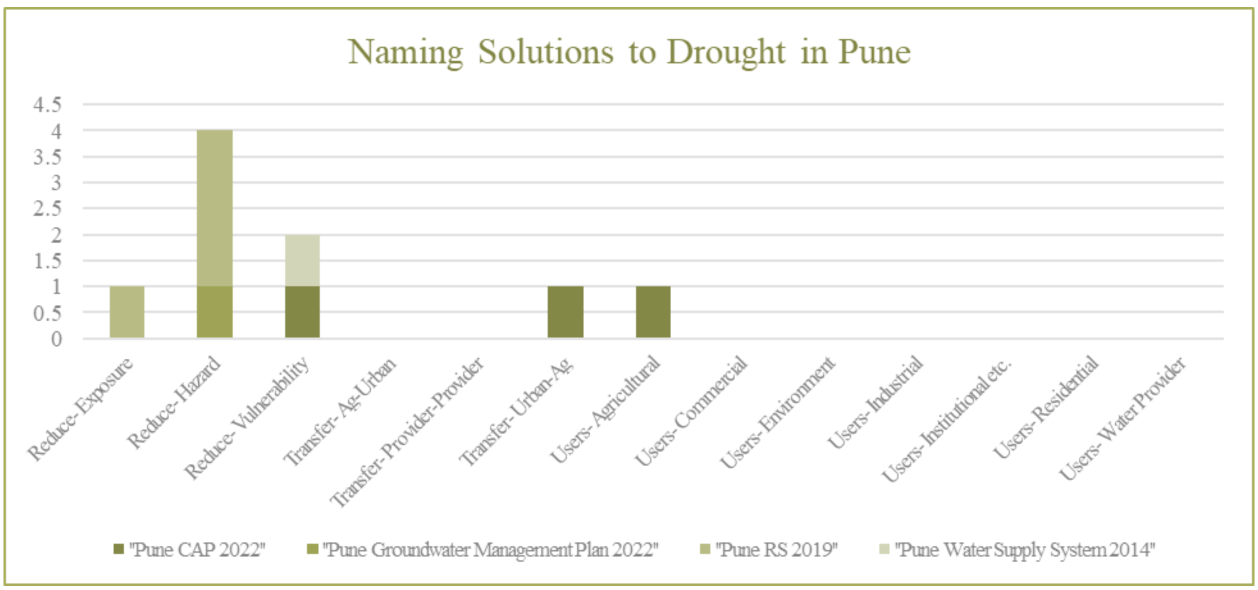

Figure 33. The number of instances each Naming Solutions code was found within Pune's network of plans.

5.1.9 Amman, Jordan

A Political impetus marks a unique feature of Amman's sense-making for drought (Figure 34), as Amman relies on imported water which is governed by international agreements with Egypt, Israel, Lebanon, and Syria. Amman is currently struggling to provide sufficient water to its population, particularly refugees who have been displaced by nearby international conflicts, providing

Political impetus as well: “The population currently receive much less than the recommended WHO standard of 120 liters/person/day and this has been aggravated by the Syrian refugees” (“Amman RS 2017”, p. 70). Like many cities within this study, Amman is located in an arid region and acknowledges this as an Environmental impetus which makes it necessary to prepare for drought. Similarly, Climate Change and Increasing Water Demand are the two main drivers of drought in Amman, and the most frequent of the naming the problem codes for the city (Figure 35). Reduce- Exposure is the main solution proposed, mainly through water loss reduction and rainwater capture and reuse, implicating the Water Provider and city (Institutional) as the users responsible for implementation (Figure 36).

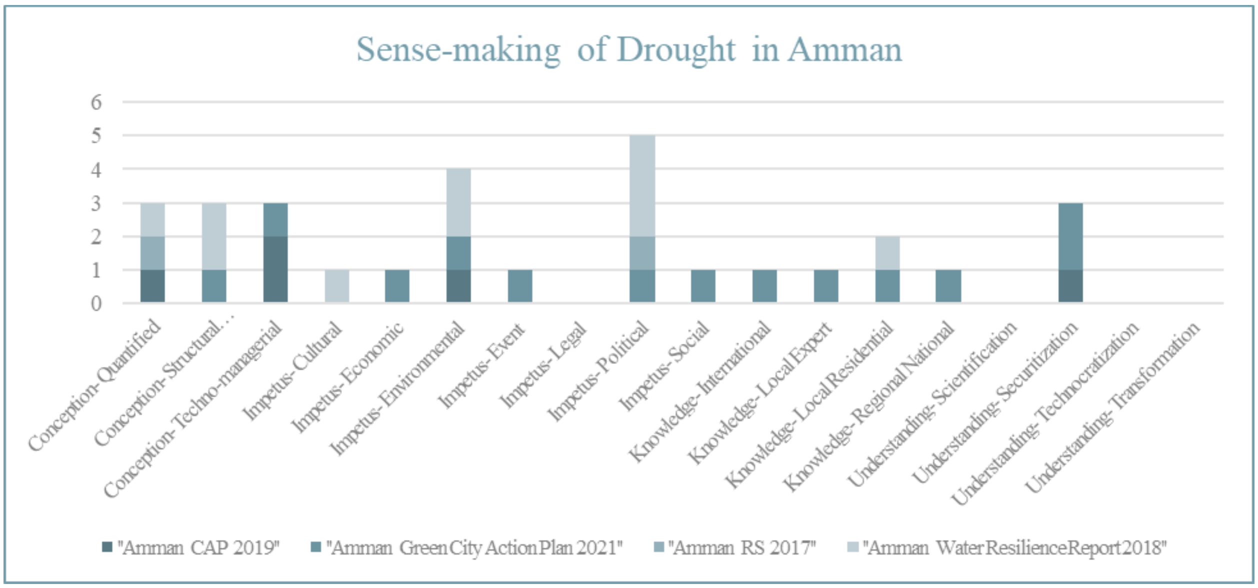

Figure 34. The number of instances each Sense-Making code was found within Amman’s network of plans.

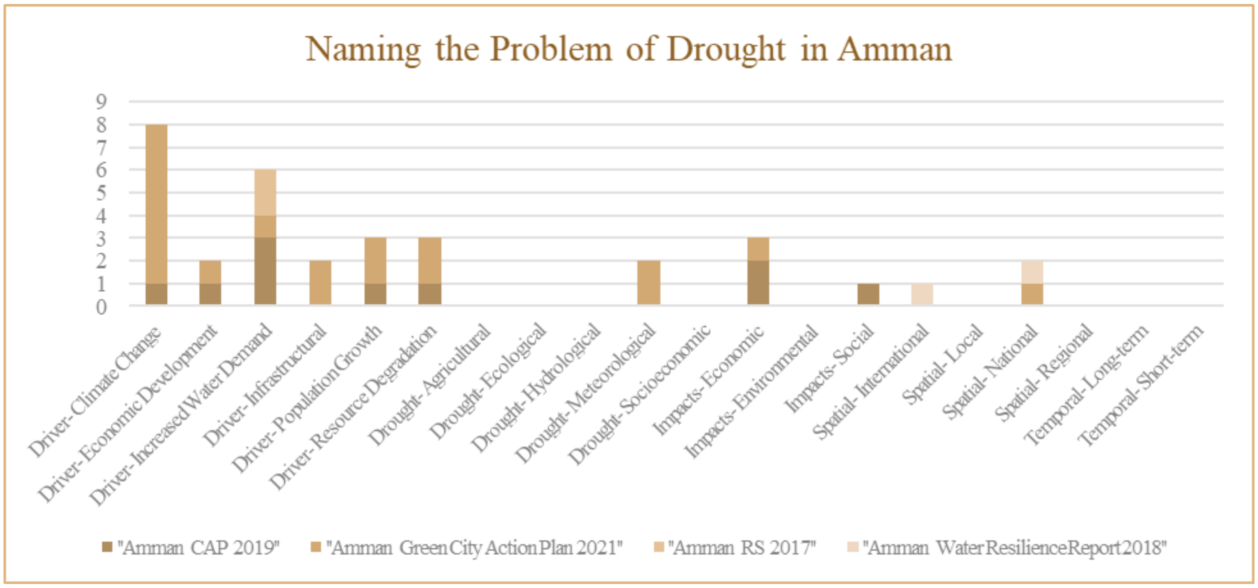

Figure 35. The number of instances each Naming the Problem code was found within Amman's network of plans.

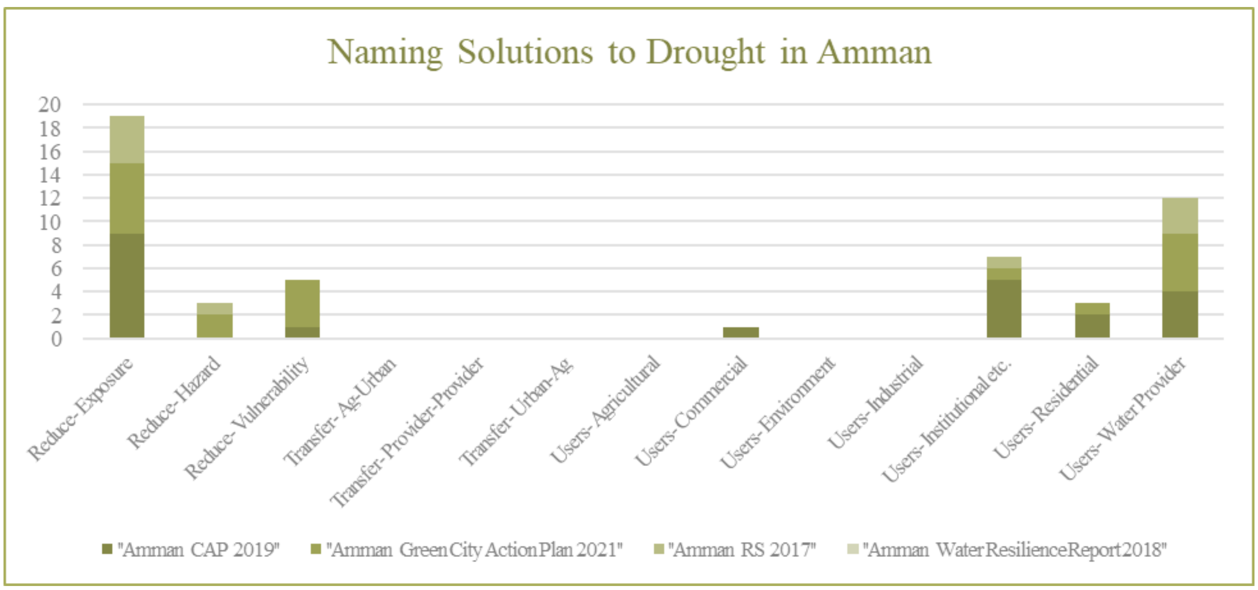

Figure 36. The number of instances each Naming Solutions code was found within Amman's network of plans.

5.1.10 Auckland, New Zealand

Auckland has a relatively even distribution among several of the sense-making codes, with Scientification and Securitization edging out a Quantified conception and Cultural and Event impetuses by one (Figure 37). One instance of Transformative understanding is used by Auckland, as they propose to change their community's relationship with water through Indigenous Māori principles. Climate Change is recognized as the central driver of drought, and both Hydrological and Meteorological drought definitions inform Auckland's plans to an extent (Figure 38). Auckland employs each of the Reduce- codes and implicates several of the User categories with these solutions as well (Figure 39). This indicates relatively holistic sense-making and problem-solving for drought within Auckland, although there is room for further problem definition as well.

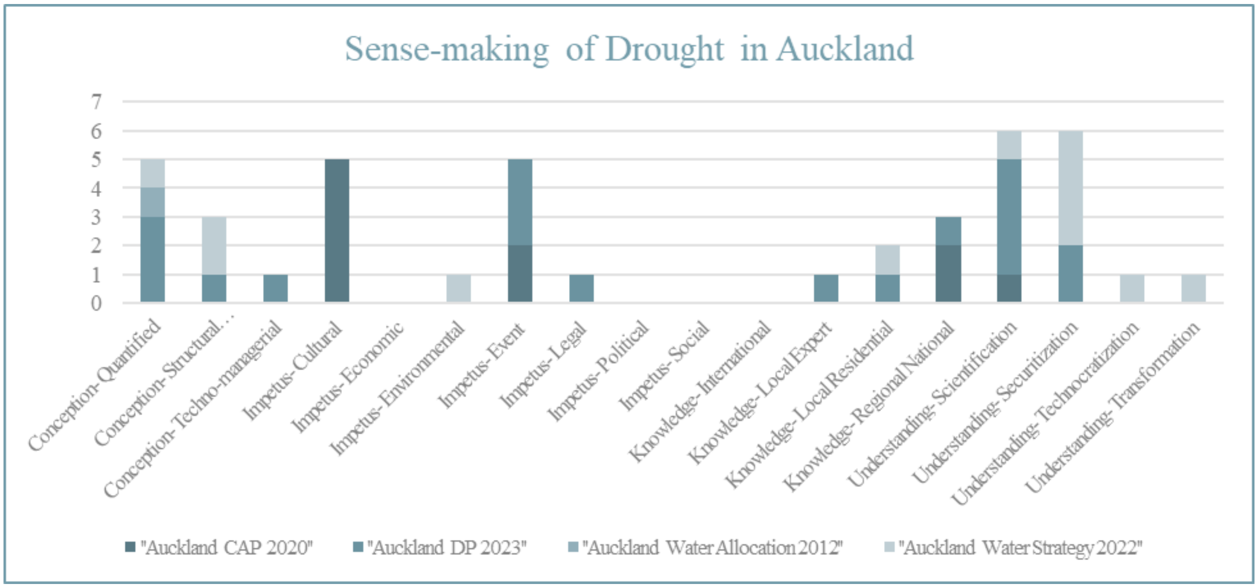

Figure 37. The number of instances each Sense-Making code was found within Auckland's network of plans.

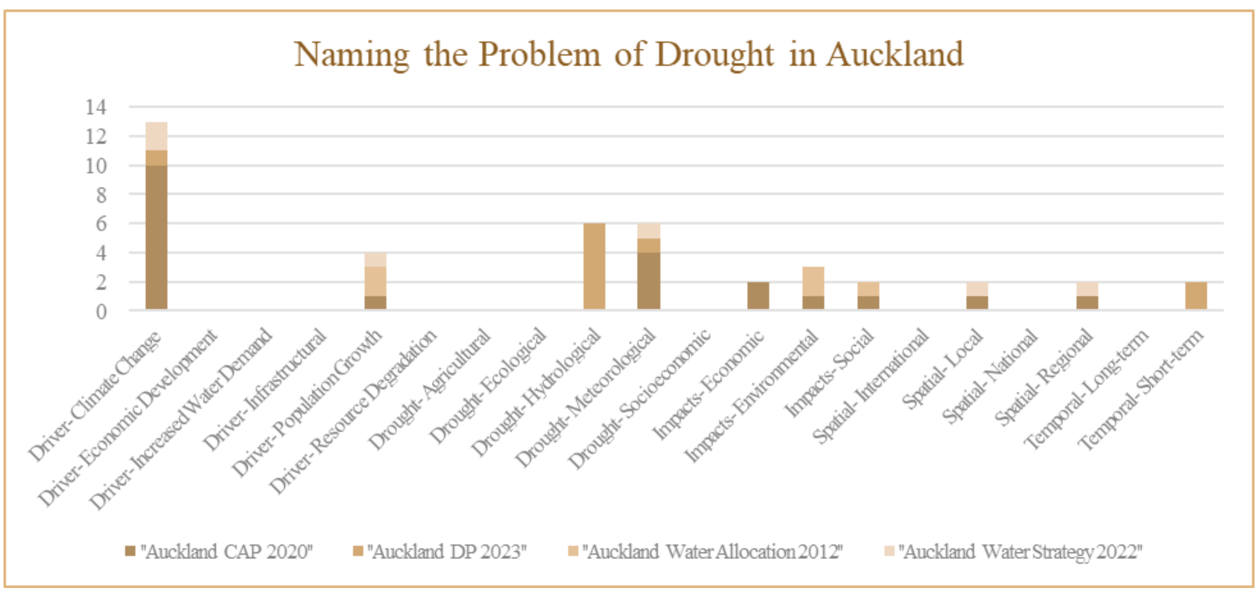

Figure 38. The number of instances each Naming the Problem code was found within Auckland's network of plans.

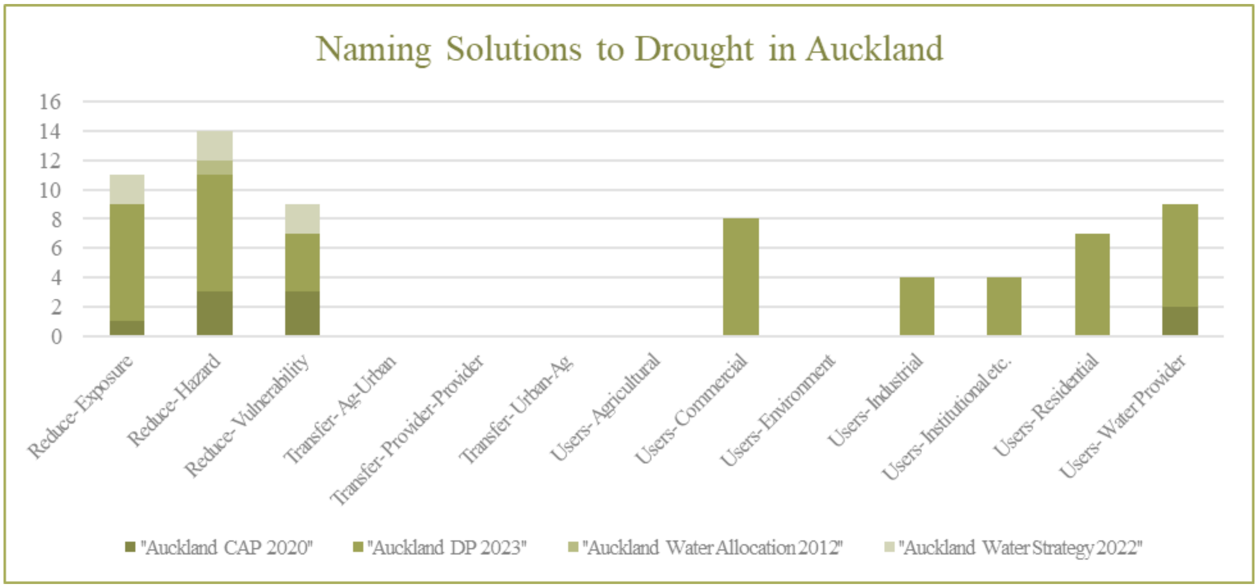

Figure 39. The number of instances each Naming Solutions code was found within Auckland's network of plans.

5.1.11 Christchurch, New Zealand

Christchurch is another city in this cohort that has lesser concern about drought, especially in the more abstract codes within sense-making, where Scientification and Transformation are the only codes to appear, and only once each (Figure 40). Like Auckland, the Transformation coded text relays the incorporation of Indigenous Māori principles into planning. Christchurch is more specific about the problems of drought, naming Climate Change as the driver and Environmental Impacts as primary concerns (Figure 41). Within these codes, there is particular apprehension about the compounding impacts of drought and wildfire together. The solution proposed is Reduce- Exposure, wherein the coded text is solely about water conservation (Figure 42).

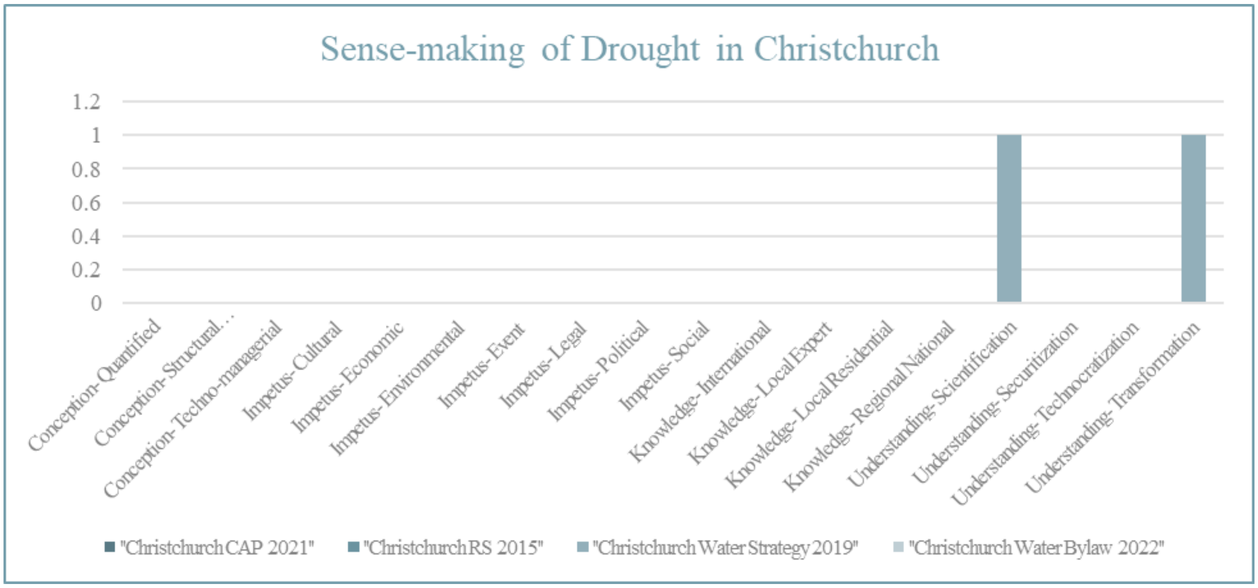

Figure 40. The number of instances each Sense-Making code was found within Christchurch's network of plans.

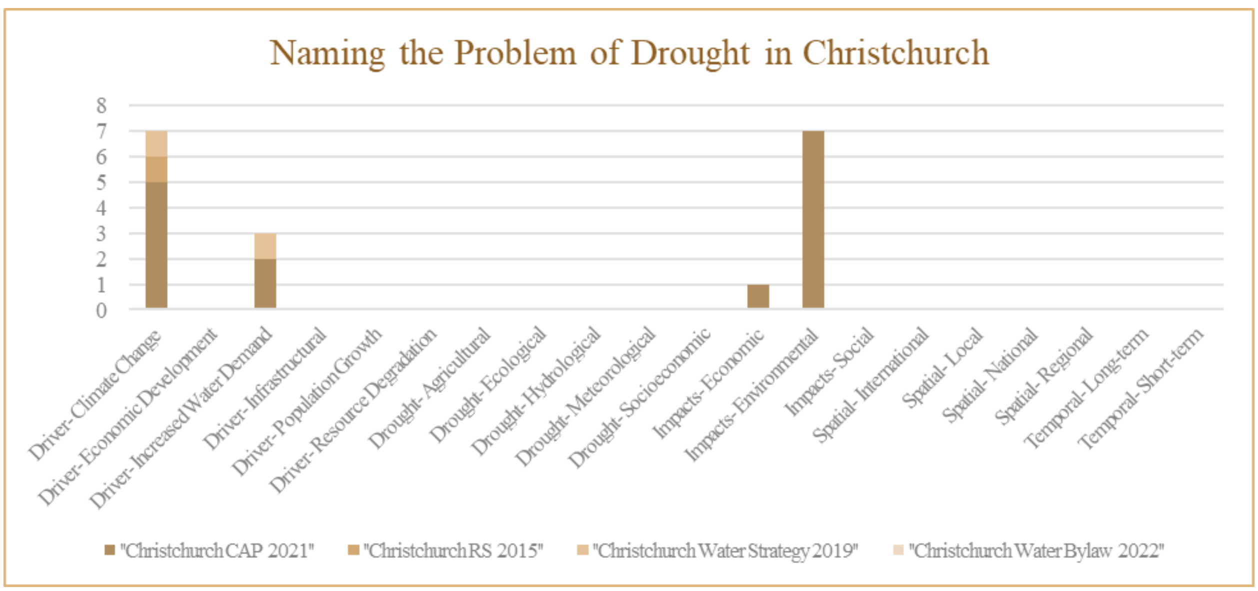

Figure 41. The number of instances each Naming the Problem code was found within Christchurch's network of plans.

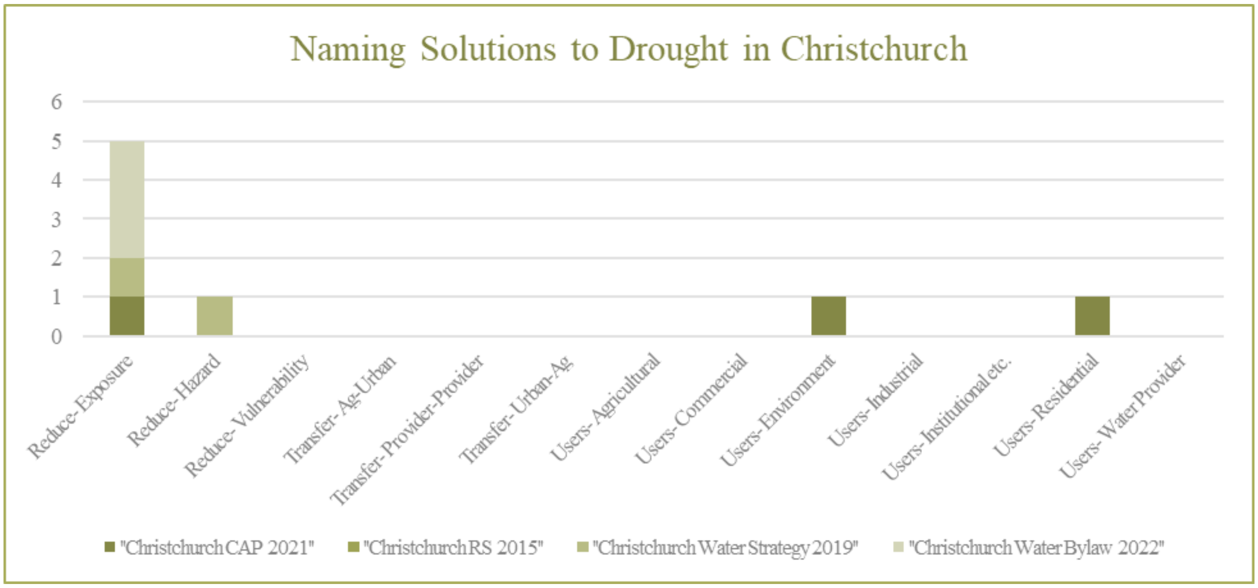

Figure 42. The number of instances each Naming Solutions code was found within Christchurch's network of plans.

5.1.12 Wellington, New Zealand

Wellington has low prevalence across many of the sense-making codes, with a Technocratized understanding most prevalent at three instances (Figure 43). The city engages with drought definitions within the naming the problem codes more frequently than other cities (Figure 44). Despite low prevalence of sense-making or naming the problem codes, Wellington has numerous solution codes, particularly for Reduce- Exposure wherein the city strives to reduce peak summer demands during seasonal low rainfall due to low availability of water storage (Figure 45). As such, its target users are the various customer classes rather than the water provider or the environment.

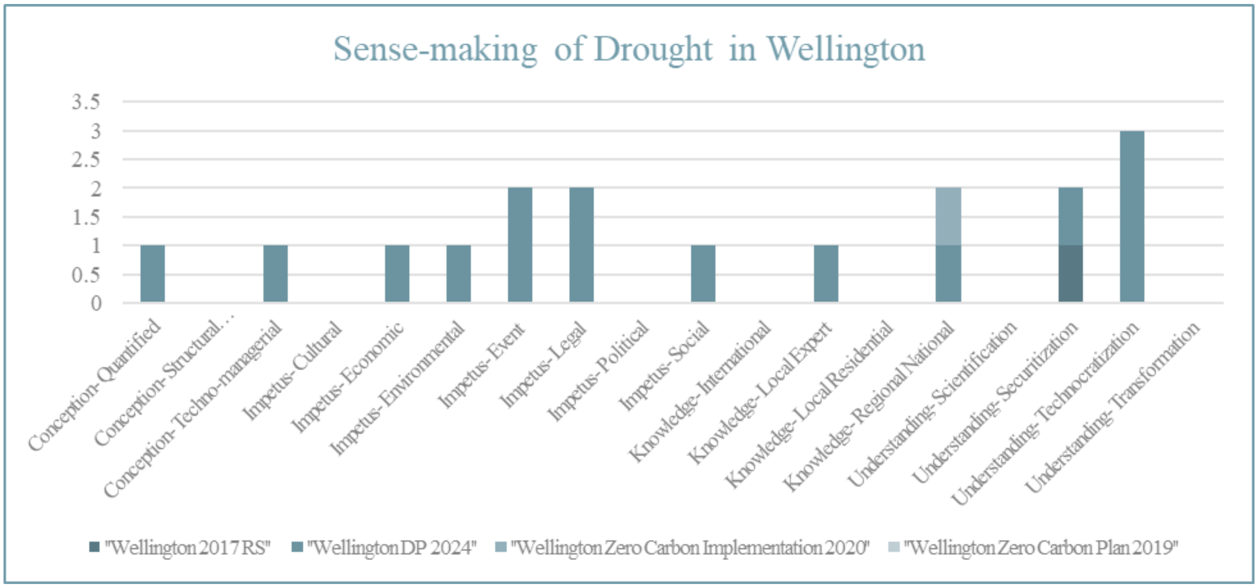

Figure 43. The number of instances each Sense-Making code was found within Wellington's network of plans.

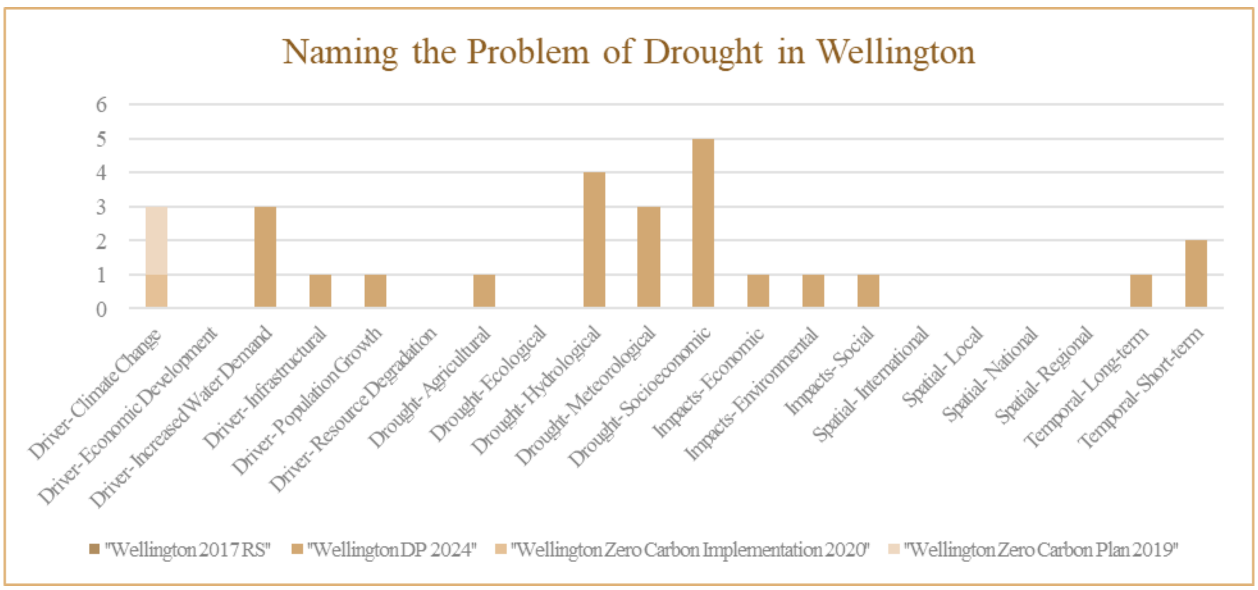

Figure 44. The number of instances each Naming the Problem code was found within Wellington's network of plans.

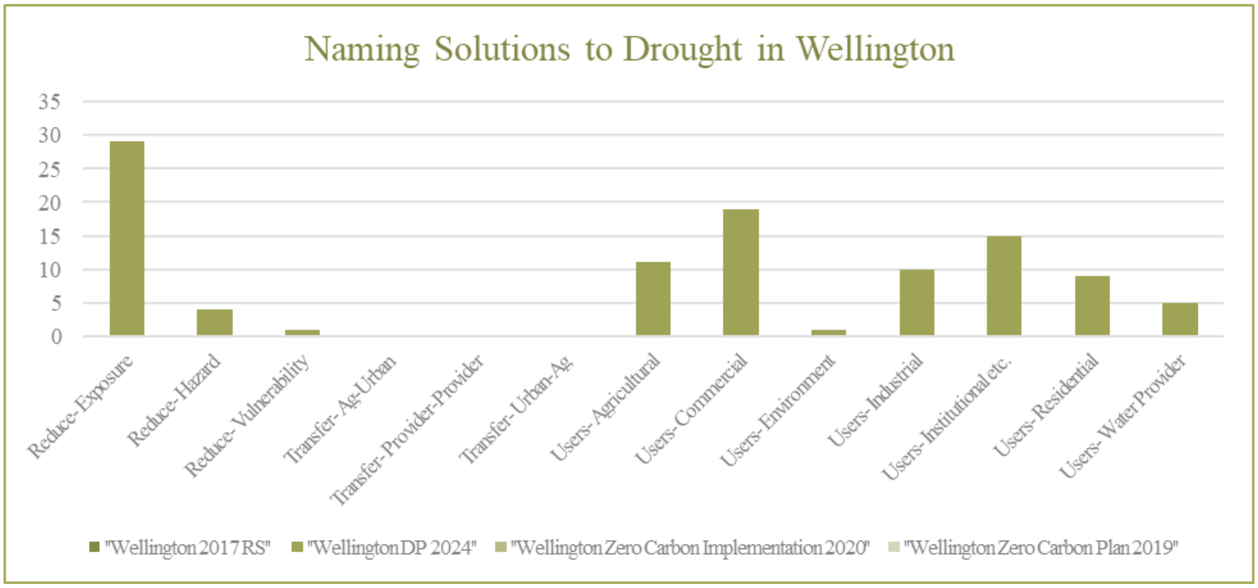

Figure 45. The number of instances each Naming Solutions code was found within Wellington's network of plans.

5.1.13 Singapore, Singapore

Singapore makes sense of drought through the Securitization and Technocratization modes of understanding (Figure 46), the intersection of which is evidenced by this excerpt: "It will become quickly apparent to the reader that the future of Singapore's water security lies with desalination and reuse… and use science and technology to overcome our water challenges" ("Singapore PUB Our Water Future 2020", p. 5). The problem of drought in the city is Increased Water Demand over all other drivers and naming the problem codes (Figure 47). Along with this, Singapore receives heavy rainfall, but lacks the ability or land area to store it, contributing to its water availability concerns and providing explanation for Reduce- Hazard as its most prevalent solution code (Figure 48).

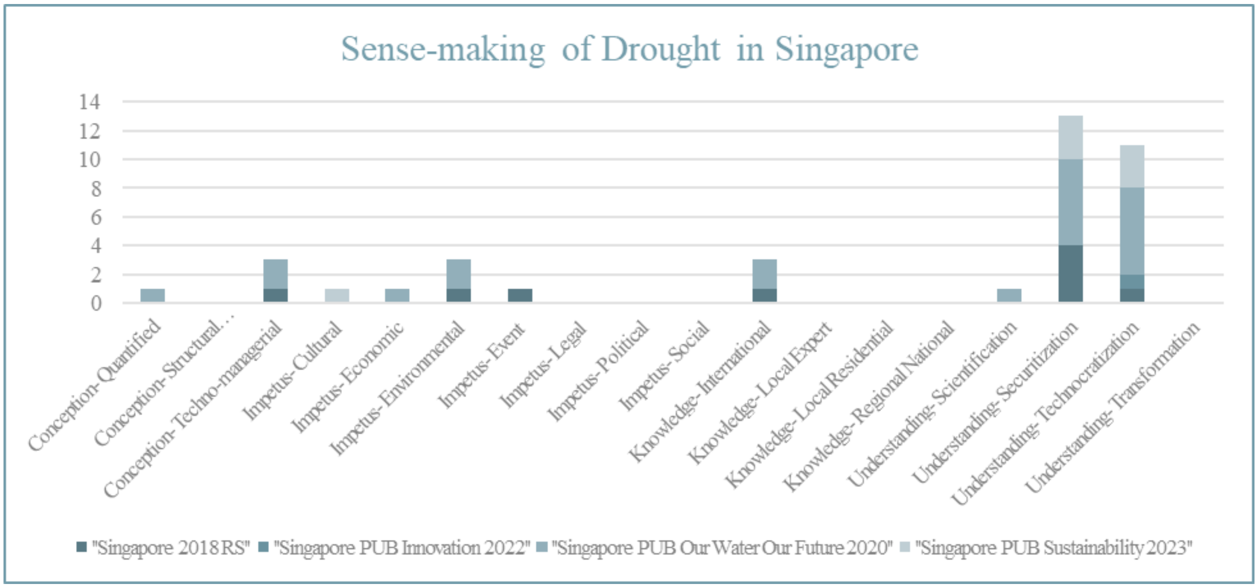

Figure 46. The number of instances each Sense-Making code was found within Singapore's network of plans.

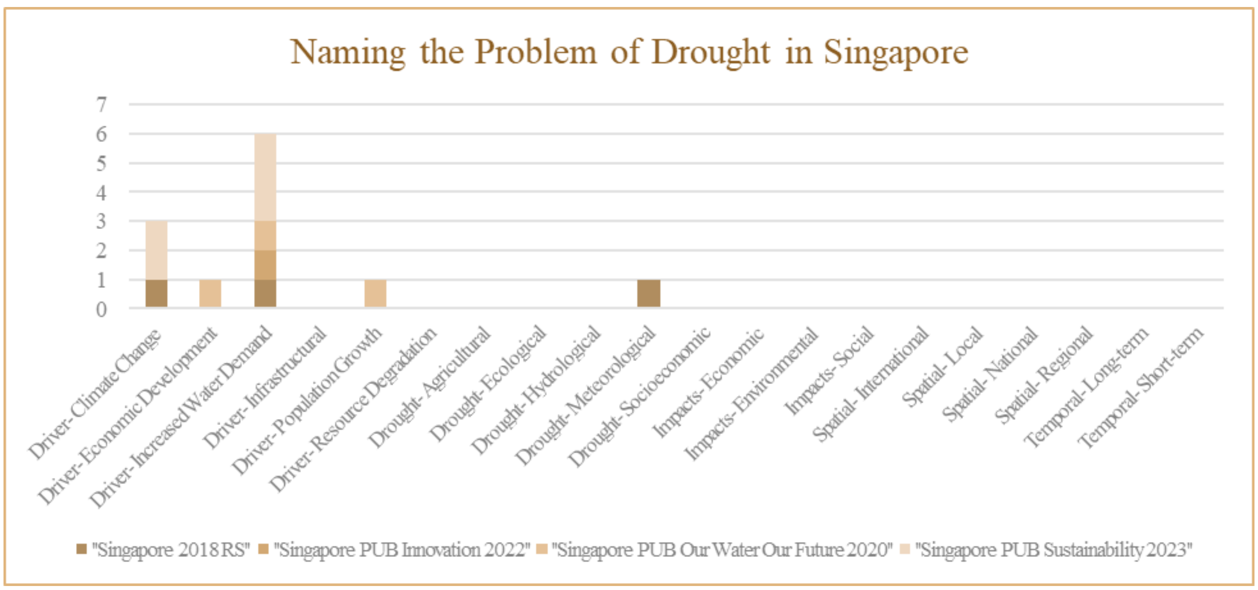

Figure 47. The number of instances each Naming the Problem code was found within Singapore's network of plans.

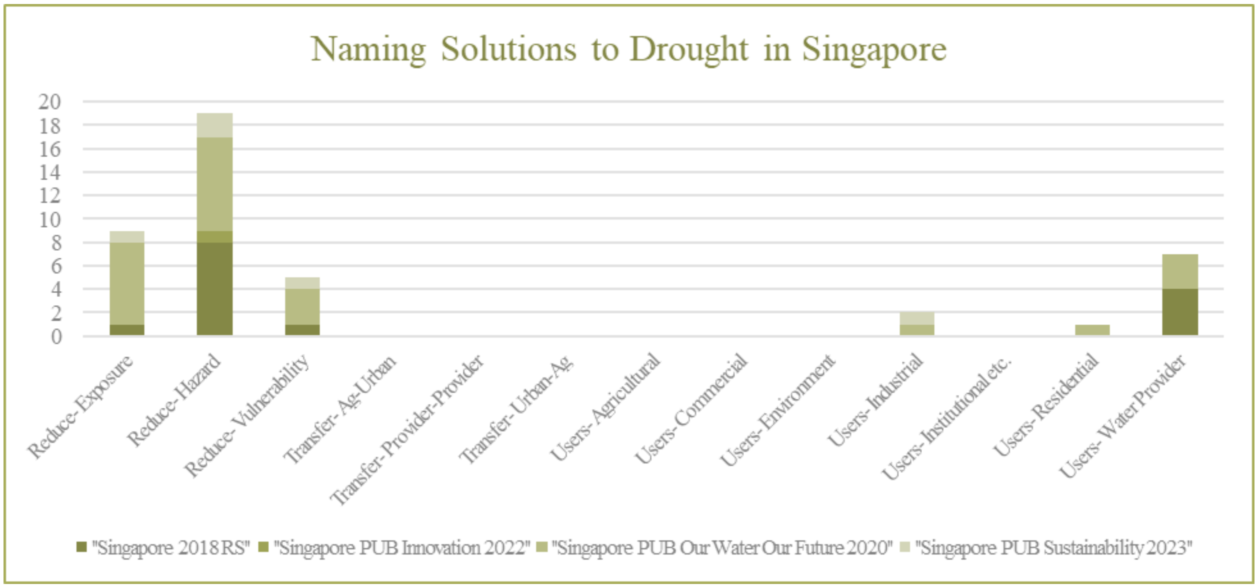

Figure 48. The number of instances each Naming Solutions code was found within Singapore's network of plans.

5.1.14 Cape Town, South Africa

Cape Town makes sense of drought through lessons learned from its 2015-2019 drought, and particularly nearing Day Zero in 2017 and 2018 (Figure 49). In addition to an Event impetus, Cape Town has a Quantified conception and a Technocratization understanding of drought. The city identifies Climate Change as the main driver—in this case, potentially to the detriment of other causations, as few other codes within this section are present (Figure 50). A trend in Cape Town's plans was that the City's previous water supply standards of 98% reliability were supposed to suffice for severe drought, and because they did not from 2015-2019 due to the lack of rainfall caused by climate change, the City is moving toward 99.5% system reliability ("Cape Town Water Supply Strategy 2019"). The solutions that result are concentrated in the Reduce- Hazard code and prioritise augmenting water supplies: supplies with higher reliability metrics and which are rainfall-independent (Figure 51).

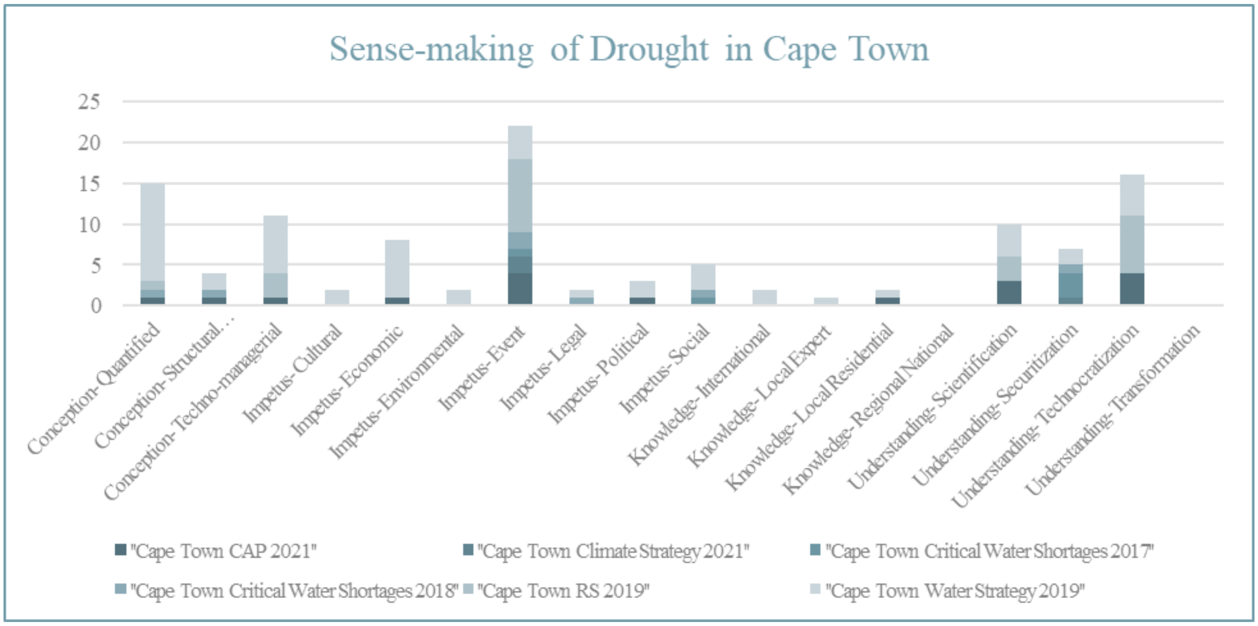

Figure 49. The number of instances each Sense-making code was found within Cape Town's network of plans.

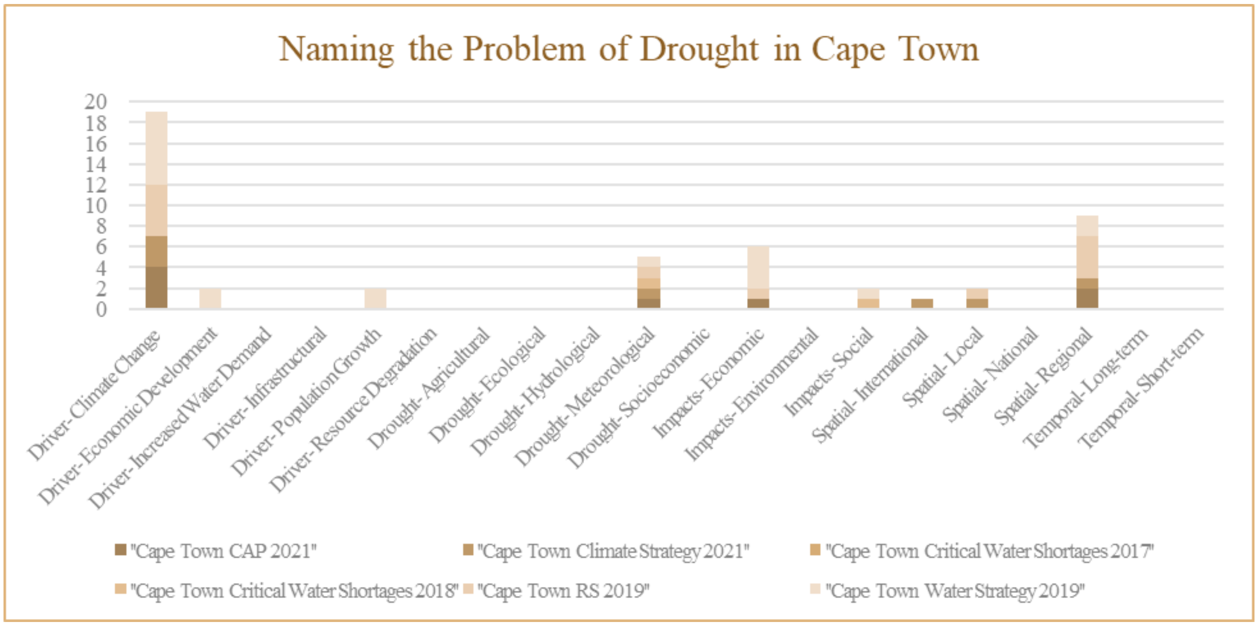

Figure 50. The number of instances each Naming the Problem code was found within Cape Town's network of plans.

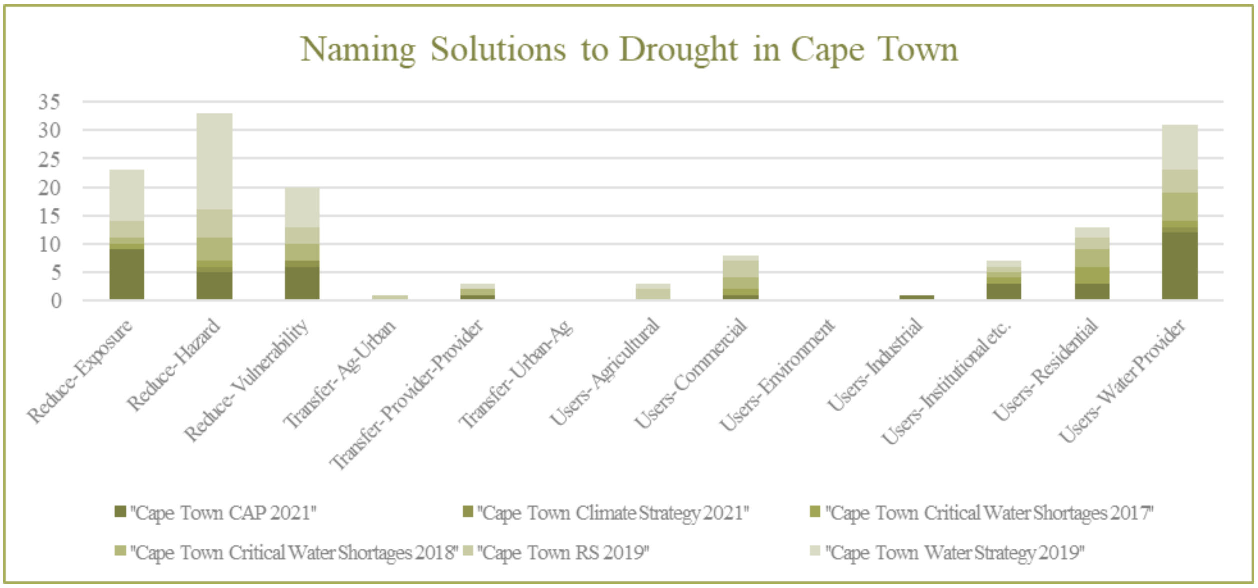

Figure 51. The number of instances each Naming Solutions code was found within Cape Town's network of plans.

5.1.15 Durban (eThekwini), South Africa

The City of Durban makes sense of drought mainly through a Securitization understanding and Quantified conception, with many other sense-making codes present as well (Figure 52). Essentially, Durban strives to close its water supply-demand gap with acknowledgement of social equity (Impetus- Social) and cost-effectiveness (Impetus- Economic). The problem of drought was again named to be Climate Change above all other investigated factors (Figure 53). Reduce-Exposure was the top solution named, with a focus on reducing water losses and implementing rainwater harvesting (Figure 54).

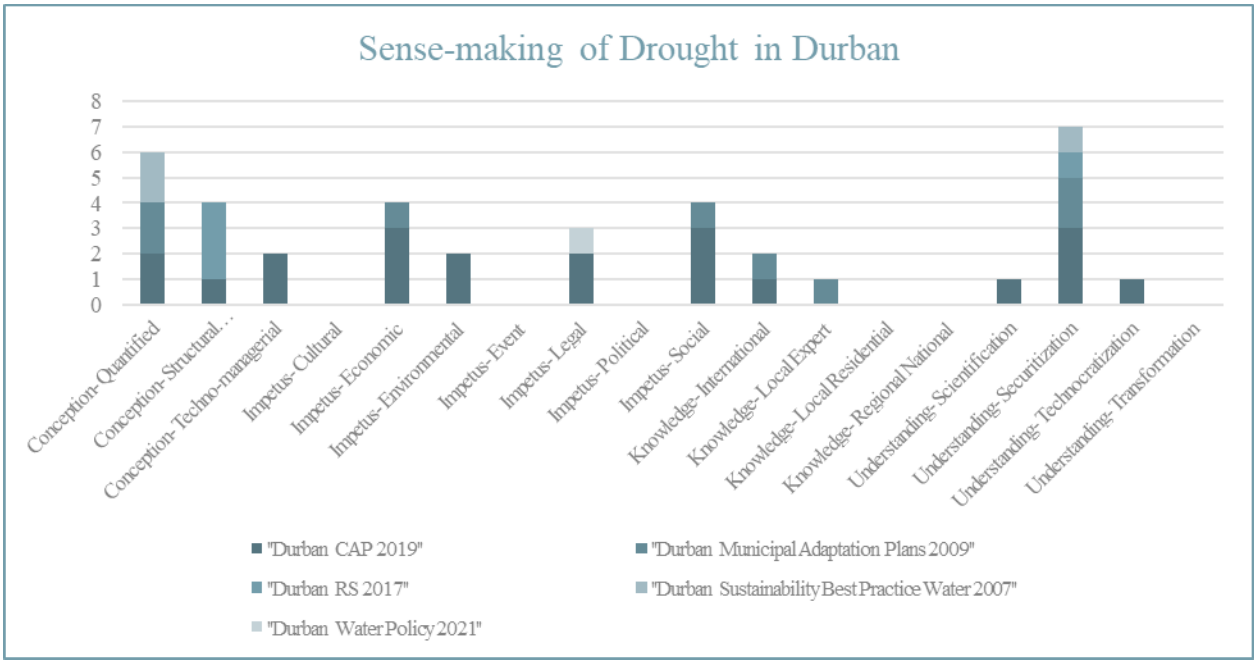

Figure 52. The number of instances each Sense-making code was found within Durban's network of plans.

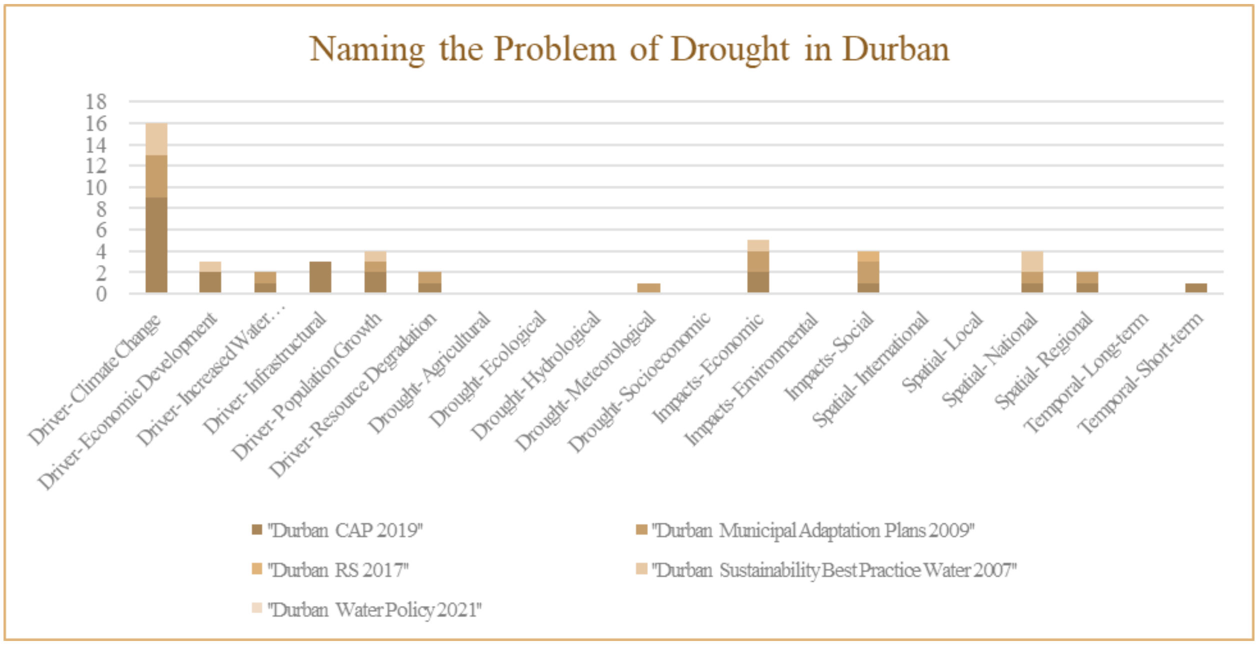

Figure 53. The number of instances each Naming the Problem code was found within Durban's network of plans.

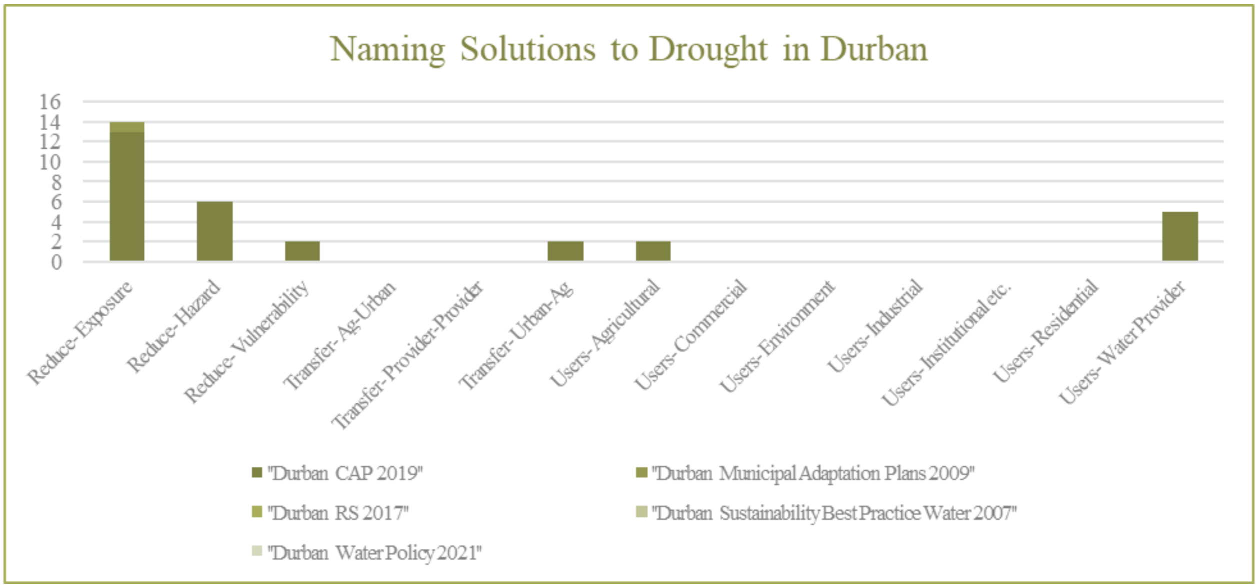

Figure 54. The number of instances each Naming Solutions code was found within Durban's network of plans.

5.1.16 Johannesburg, South Africa

The main mode of sense-making of drought in Johannesburg is Securitization (Figure 55). Johannesburg assessed the vulnerability of its neighbourhoods to climate change risks, including drought, providing a sophisticated showing of the Structural/Distributional conception of drought risk ("Johannesburg CAP 2021"). Climate Change is seen as the main cause of drought within Johannesburg, followed by Infrastructural shortcomings, both in extent throughout the city and because of high rates of water leakages (Figure 56). Uniquely for this cohort of study, Meteorological drought was explicitly recognized as the primary type of drought that the city needs to contend with. Social impacts were noted with reference to issues of water availability for the city's poorest residents, and those living in informal settlements. Because Johannesburg is reliant on piped supplies from the region and Kingdom of Lesotho, drought is recognized as a Regional and International problem. Because of this, Johannesburg has high emphasis on water recycling and reuse (Reduce- Exposure), as other alternative water supplies are considered infeasible ("Johannesburg City Resilience Profile 2022") (Figure 57). Within water reuse, there is a focus on assessing the viability of acid mine drainage reuse, due to the legacy of mining in and around the municipality which contaminated groundwater.

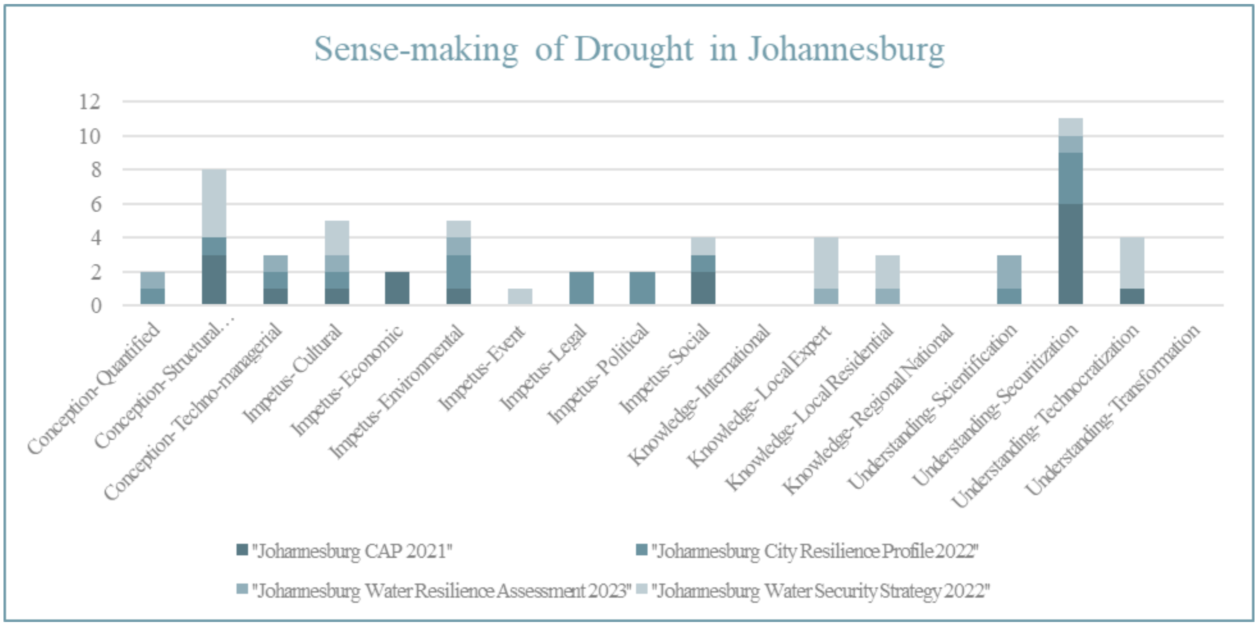

Figure 55. The number of instances each Sense-making code was found within Johannesburg's network of plans.

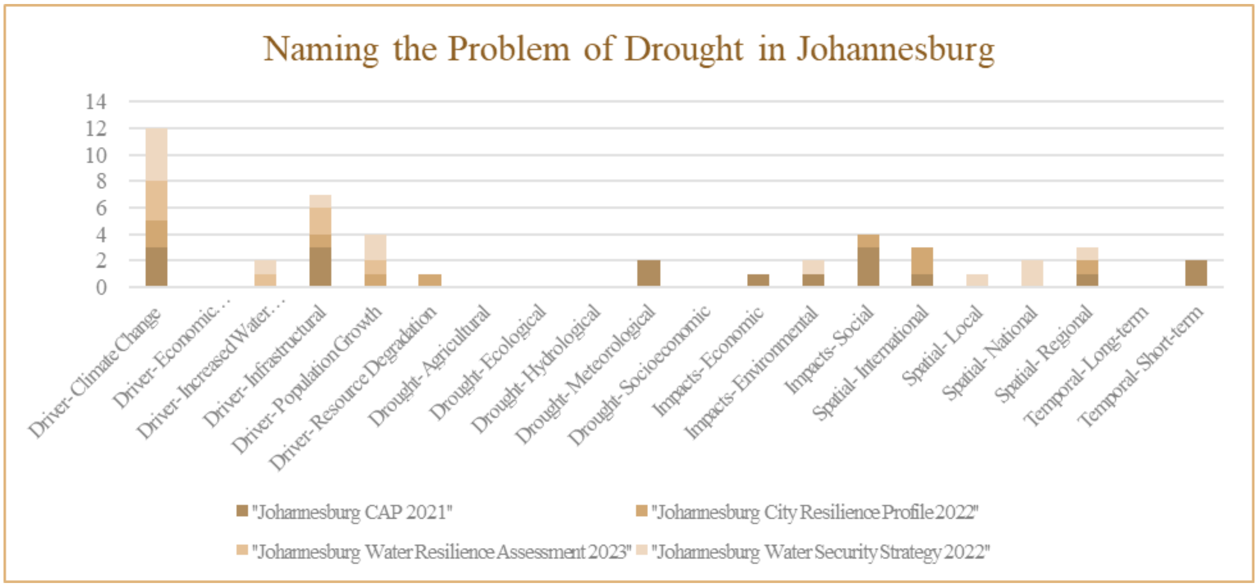

Figure 56. The number of instances each Naming the Problem code was found within Johannesburg's network of plans.

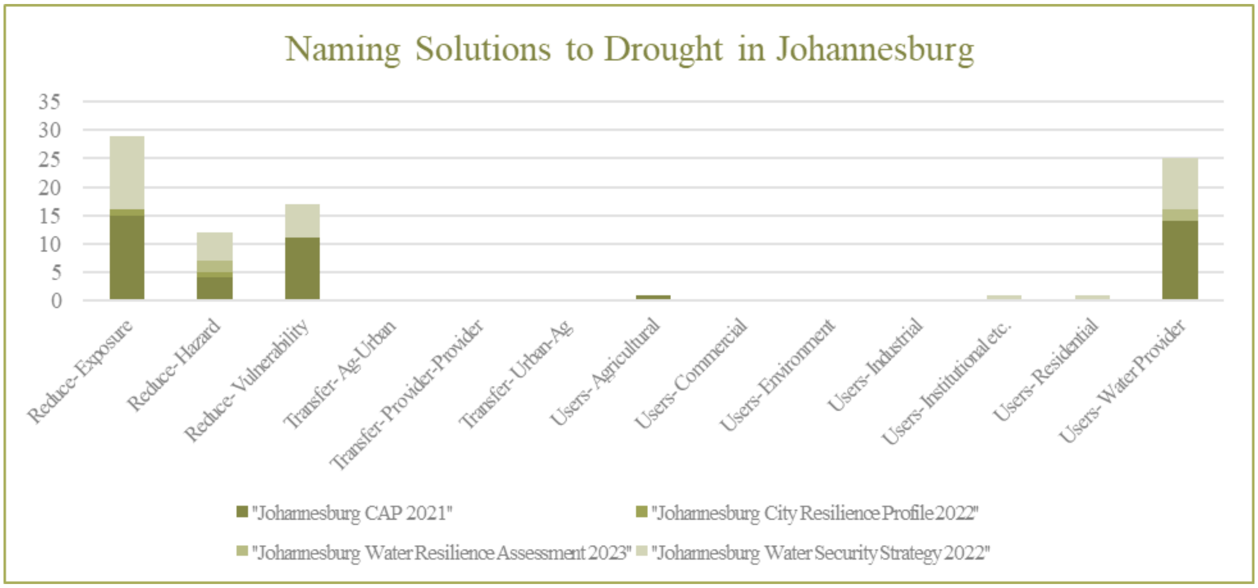

Figure 57. The number of instances each Naming Solutions code was found within Johannesburg's network of plans.

5.1.17 Bristol, United Kingdom

Drought plans are required in the United Kingdom, with regulation and review by the Environment Agency (EA) about how they should be written and what information they should contain, including drought mitigation strategies which these plans must consider (Water Industry Act, Section 39B and 39C (1991), amended by the Water Act (2003); and EA Drought Plan Guideline (2020)). As such, Scientification is prevalent among each UK city because certain types of modelling and data-gathering activities are required within a drought plan. Further, the solutions for the three UK cities tend to relate to customer communication campaigns, reducing water leaks, temporary use bans (TUBs), and water supply augmentation from groundwater or surface water. Despite this, there is still variation among the three UK cities in their drought framing and distribution of solutions.

For Bristol, the sense-making codes that appear most frequently are a Scientification understanding, Regional/National knowledge inputs (in part due to requirements to get the plan approved by the EA and collect stakeholder input before publication of the final plan), and a Legal impetus (Figure 58). The problem of drought for Bristol is mostly related to Environmental impacts, and informed by drought triggers which fall along Meteorological and Hydrological definitions of drought (Figure 59). Finally, Reduce- Exposure and Reduce- Hazard strategies are nearly equal within Bristol's plans (Figure 60).

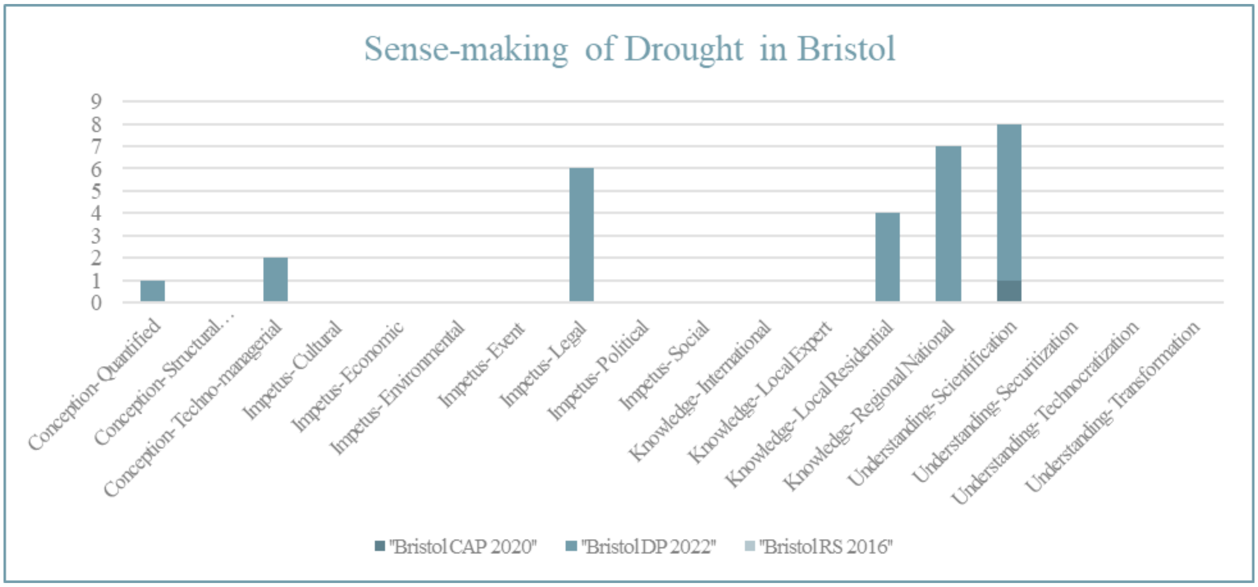

Figure 58. The number of instances each Sense-making code was found within Bristol's network of plans.

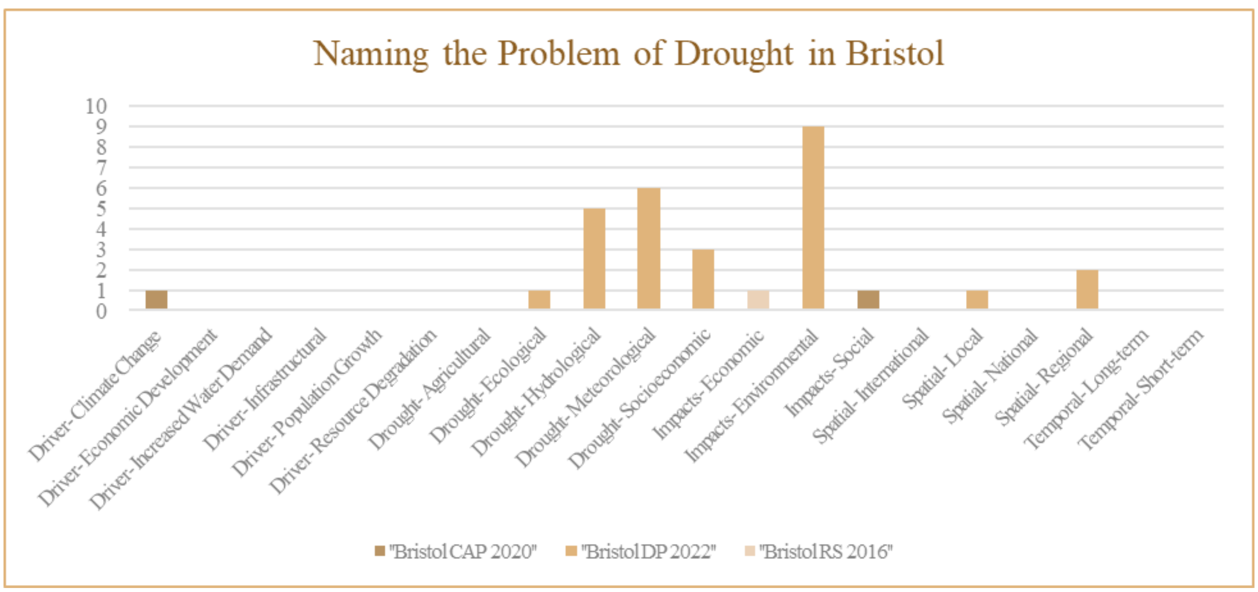

Figure 59. The number of instances each Naming the Problem code was found within Bristol's network of plans.

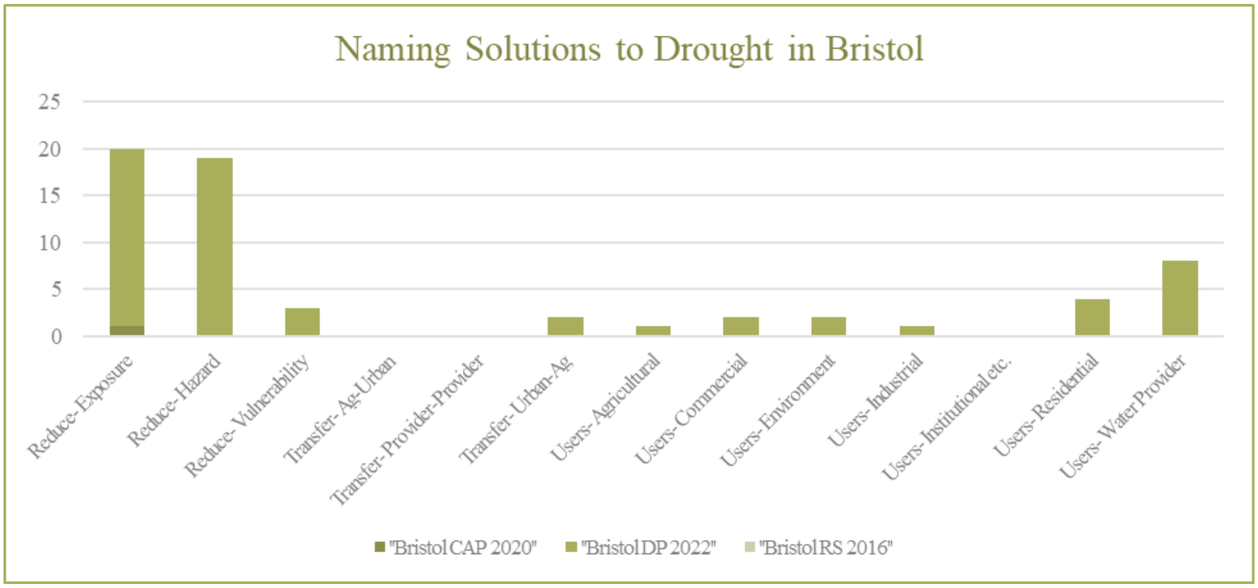

Figure 60. The number of instances each Naming Solutions code was found within Bristol's network of plans.

5.1.18 London, United Kingdom

London's sense-making of drought spans across a Scientification understanding, Legal impetus, and Quantified conception (Figure 61). An Environmental impetus also appears several times, as London is in "an area of severe water stress" ("Thames Water DP 2022", p. 8). In naming the problem of drought, London most often discusses drought triggers which are related to Hydrological and Meteorological definitions of drought (Figure 62). Reduce- Exposure and Reduce- Hazard are the two most prevalent solution codes (Figure 63).

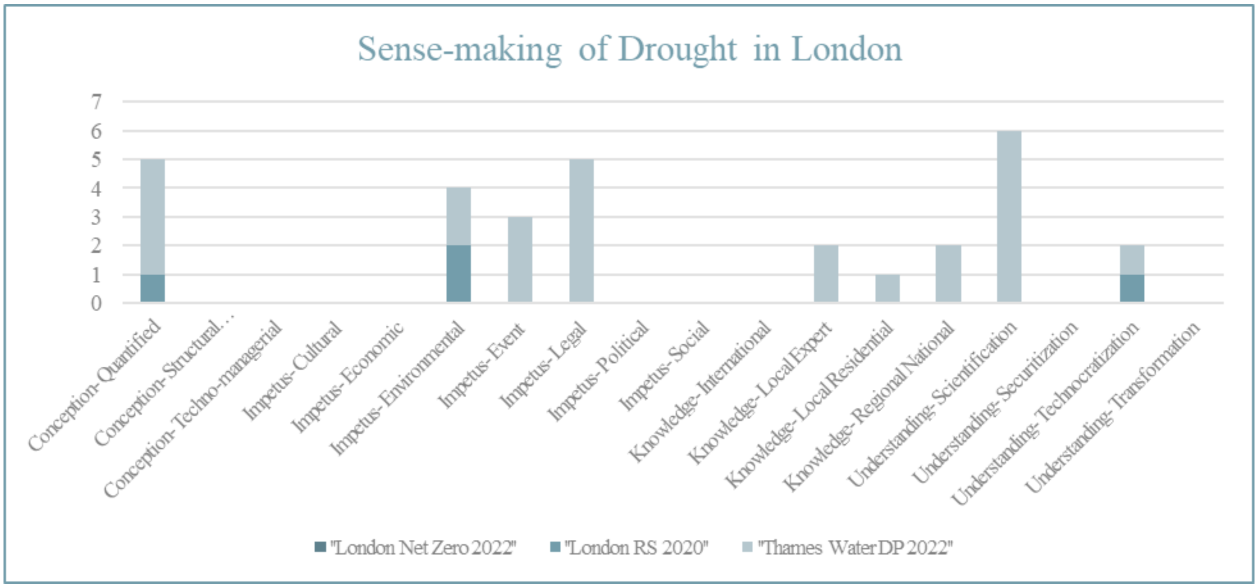

Figure 61. The number of instances each Sense-Making code was found within London's network of plans.

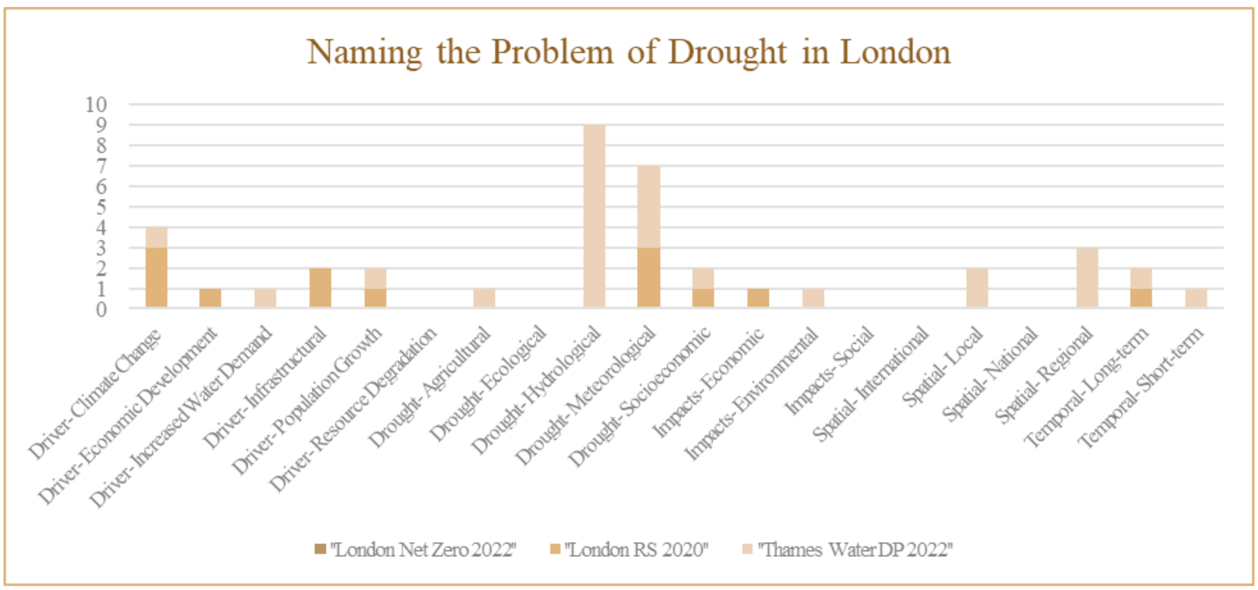

Figure 62. The number of instances each Naming the Problem code was found within London's network of plans.

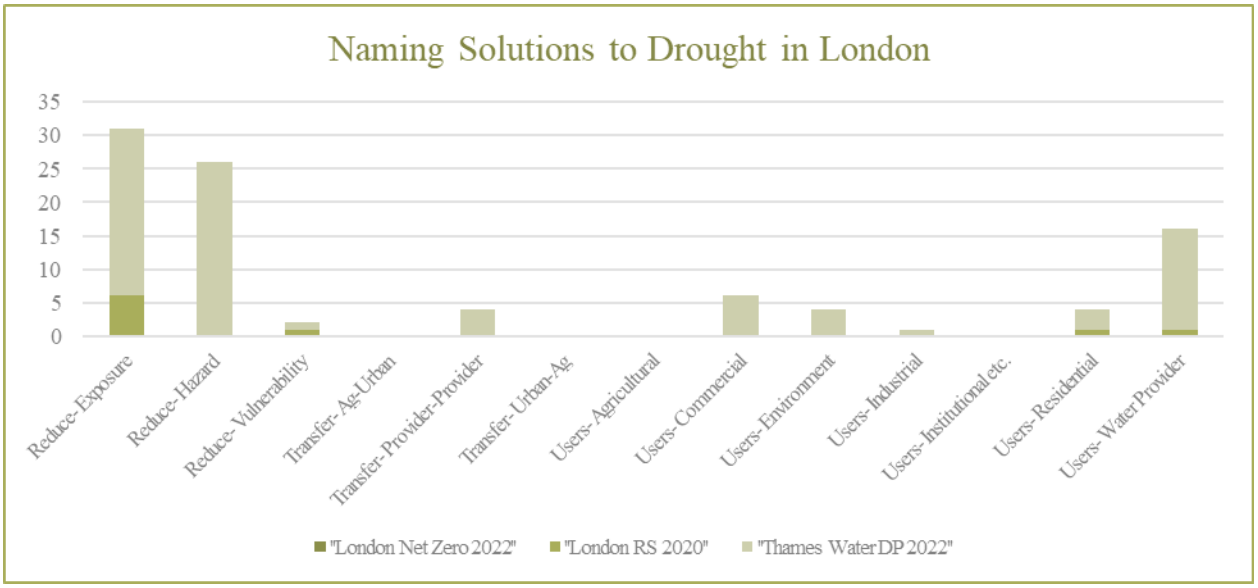

Figure 63. The number of instances each Naming Solutions code was found within London's network of plans.

5.1.19 Manchester, United Kingdom

Manchester utilises the sense-making and naming the problem codes less frequently than Bristol or London yet has similar results across the solutions codes. A Scientific understanding is most frequent within the sense-making codes, but with only four instances (Figure 64). Each naming the problem code that appears only appears once (Figure 65). Nonetheless, Reduce- Exposure and Reduce- Hazard both appear with about the same frequency in the solutions codes (Figure 66), and Manchester more explicitly attributes responsibility for these actions to the Water Provider rather than its whole customer base.

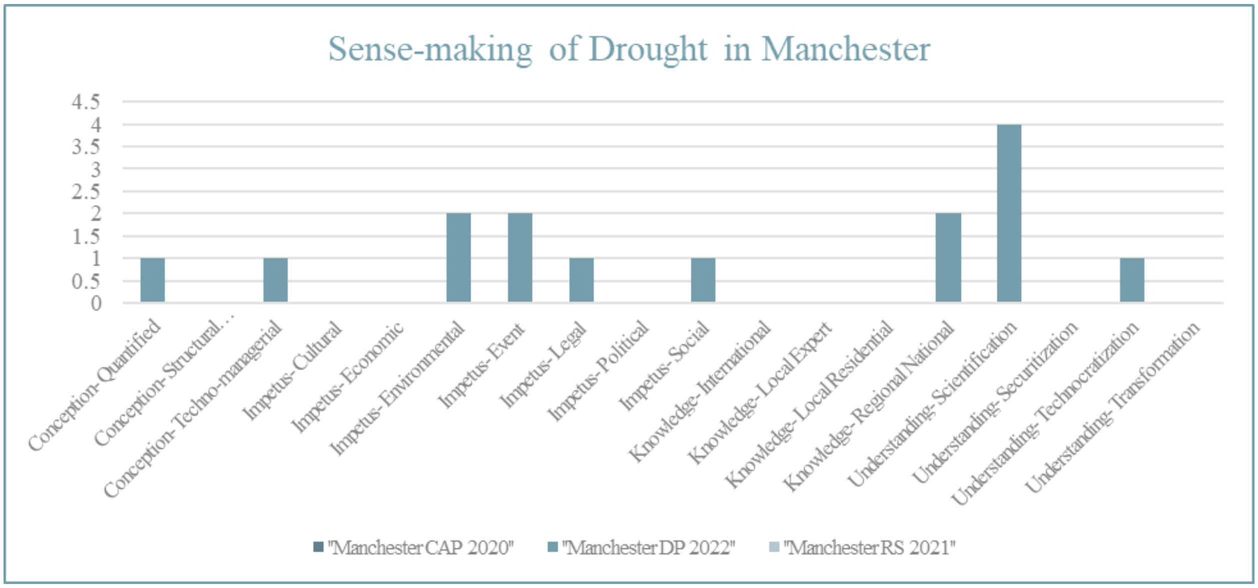

Figure 64. The number of instances each Sense-Making code was found within Manchester's network of plans.

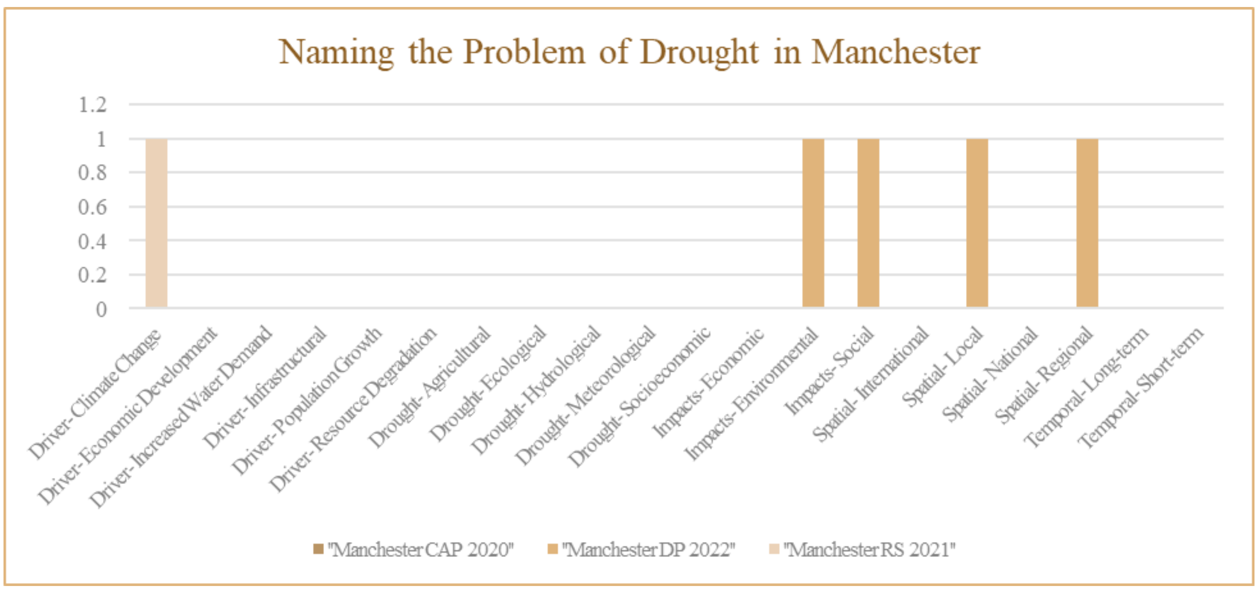

Figure 65. The number of instances each Naming the Problem code was found within Manchester's network of plans.

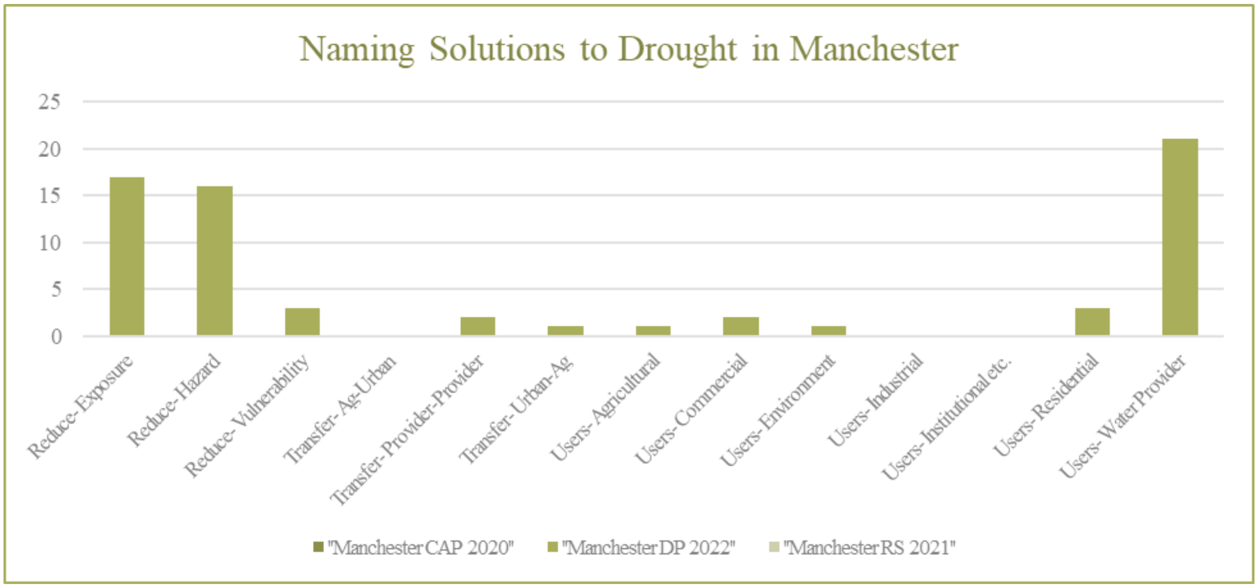

Figure 66. The number of instances each Naming Solutions code was found within Manchester's network of plans.

5.1.20 Berkeley and Oakland, United States

California has several requirements related to drought planning and water resources planning for its cities and water providers (California Water Code, Section 10632; and Urban Water Management Planning Act, Section 10635). These regulate the methods and data required in these planning documents and the content of these plans; primarily, a water supply reliability assessment. These regulations are less prescriptive about the range of solutions employed within the plans.

In Berkeley and Oakland, both served by the East Bay Municipal Utility District, sense-making of drought occurs with impetus from past drought Events and Legal requirements (Figure 67). The most frequent mode of understanding is Scientification, in part because the legal requirements for water planning in California entail specific types of water modelling which must be undertaken. These models include different scenarios anticipated under climate change, which may contribute to the prevalence of the Climate Change driver code (Figure 68). Additionally, Climate Change overshadows the other naming the problem codes for Berkeley and Oakland. Reduce- Exposure is the most prevalent solution code, followed by Reduce- Vulnerability and then Reduce- Hazard (Figure 69). Customer-targeted water conservation strategies like landscape irrigation efficiency and water-efficient fixture rebates make up most of the Reduce- Exposure coded text, and total landscape replacements with drought-tolerant species and home water audits make up much of the Reduce- Vulnerability text.

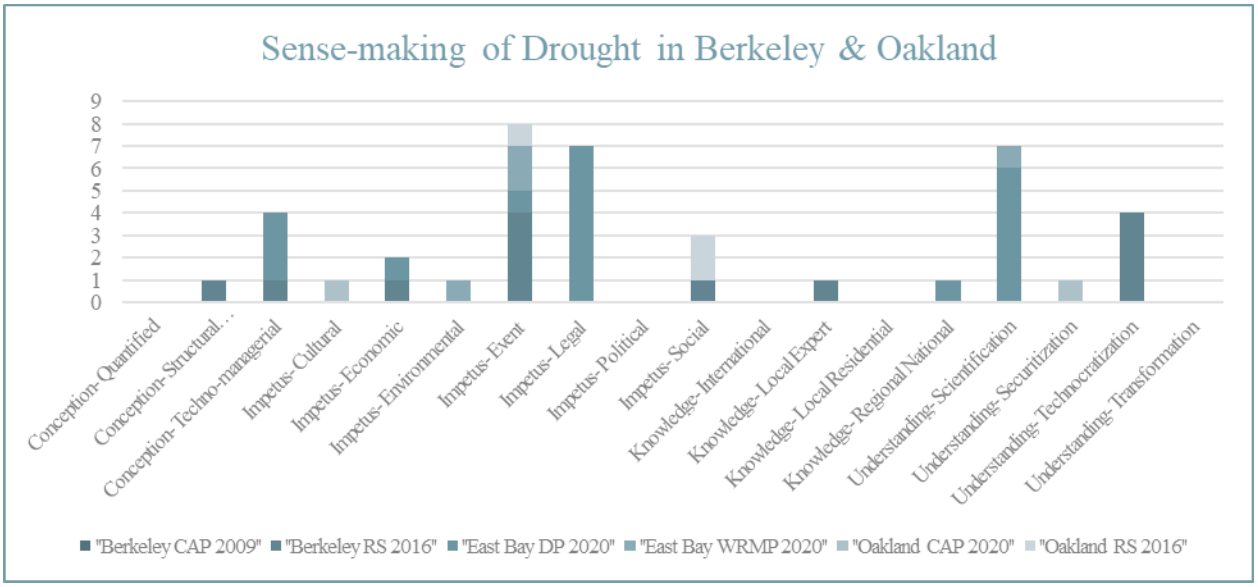

Figure 67. The number of instances each Sense-Making code was found within Berkeley and Oakland's network of plans.

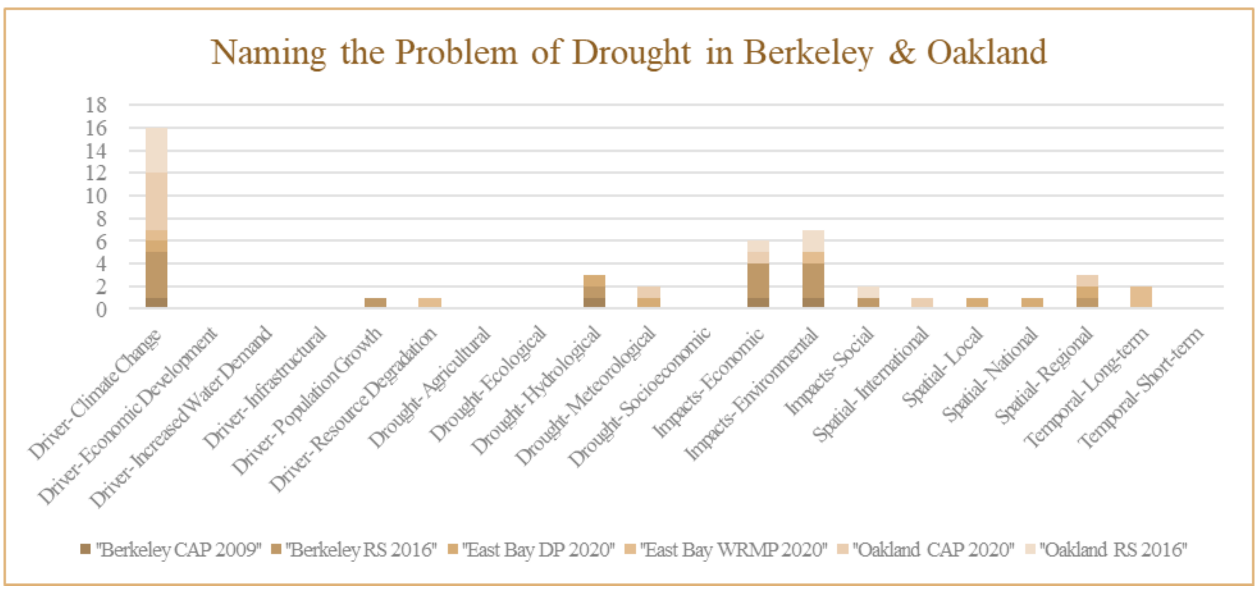

Figure 68. The number of instances each Naming the Problem code was found within Berkeley and Oakland's network of plans.

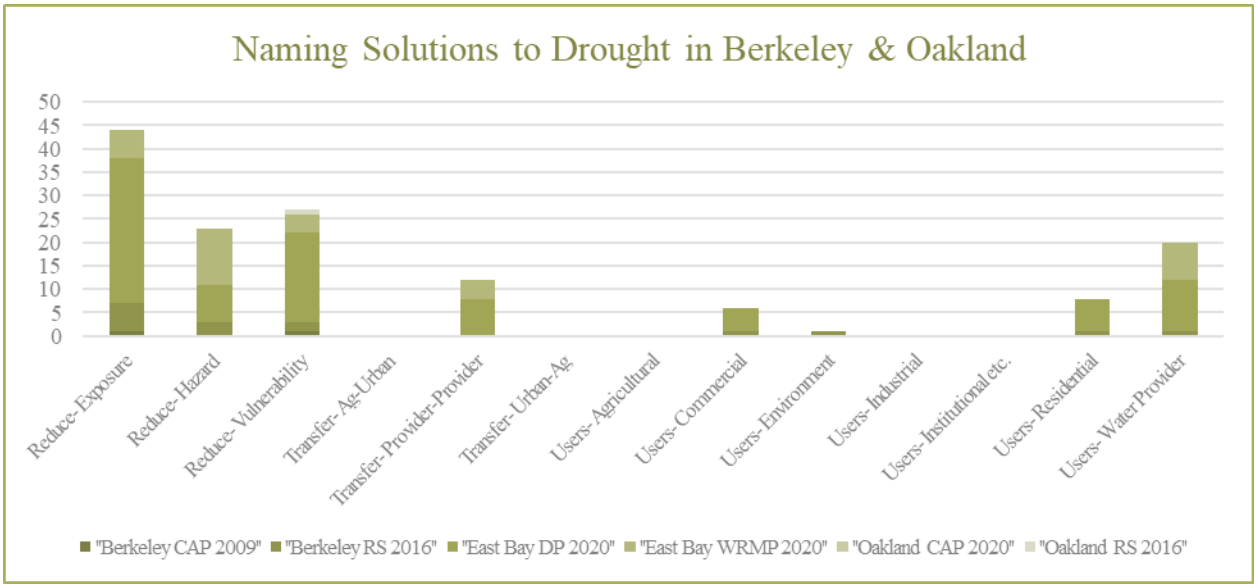

Figure 69. The number of instances each Naming Solutions code was found within Berkeley and Oakland's network of plans.

5.1.21 Los Angeles, California, United States

Los Angeles makes sense of drought mostly through the Legal and Event impetuses (Figure 70), despite the California water planning regulations which might encourage other conceptions or modes of understanding, like Scientification. This could be in part because Los Angeles identifies as having a secure water supply: "LADWP does not anticipate water shortages as demands are met by the available supplies under all hydrologic scenarios" ("LA UWMP 2020", p. 47). Environmental impacts slightly outpace Climate Change among the naming the problem codes (Figure 71), with Hydrological drought definitions and Social impacts also featuring somewhat often. Reduce- Exposure is the most prominent solution featured, followed by Reduce- Hazard and Reduce- Vulnerability (Figure 72). Notable within these codes is Los Angeles' desire to increase the availability of local water sources, so its water supply is less subject to regional impacts or water allocation politics; but augmenting supplies in this way is still dwarfed by a focus on water conservation initiatives.

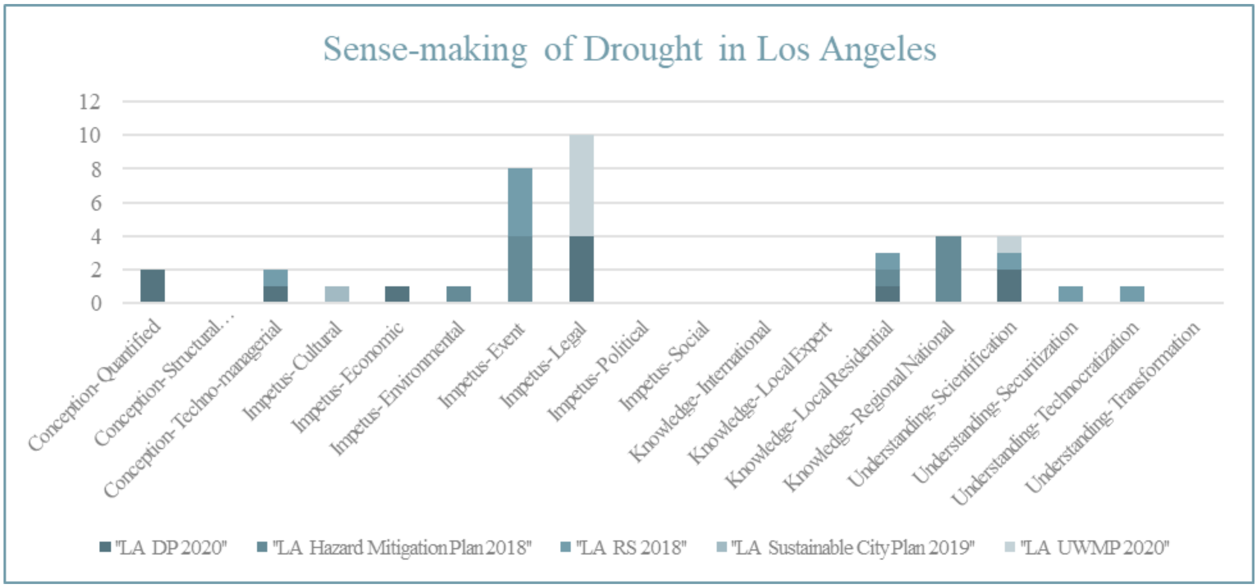

Figure 70. The number of instances each Sense-Making code was found within Los Angeles' network of plans.

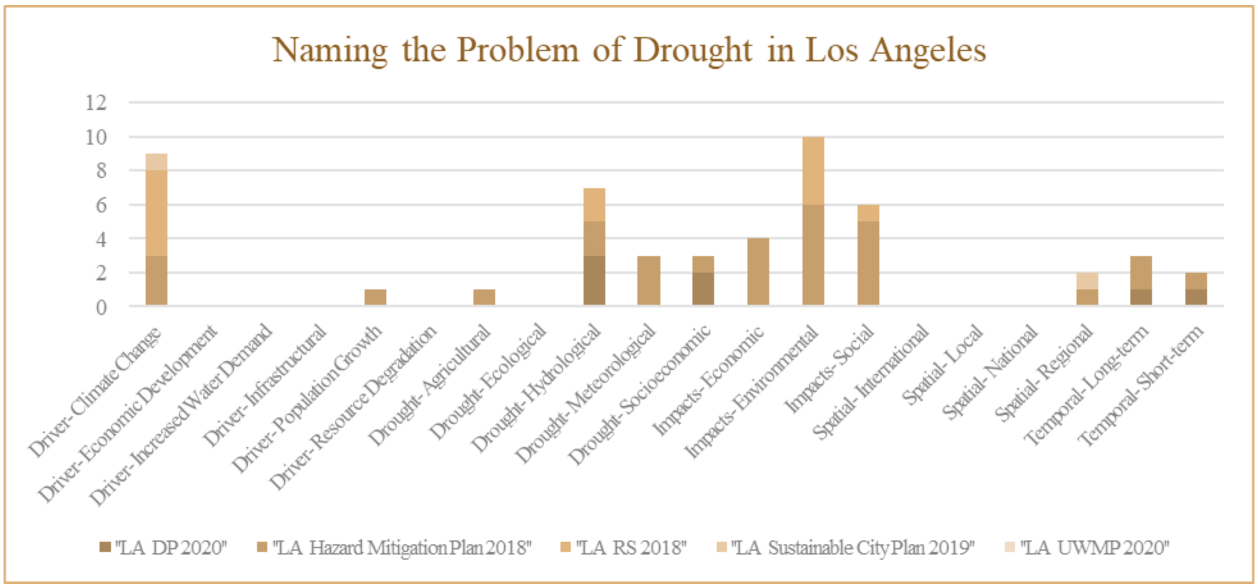

Figure 71. The number of instances each Naming the Problem code was found within Los Angeles' network of plans.

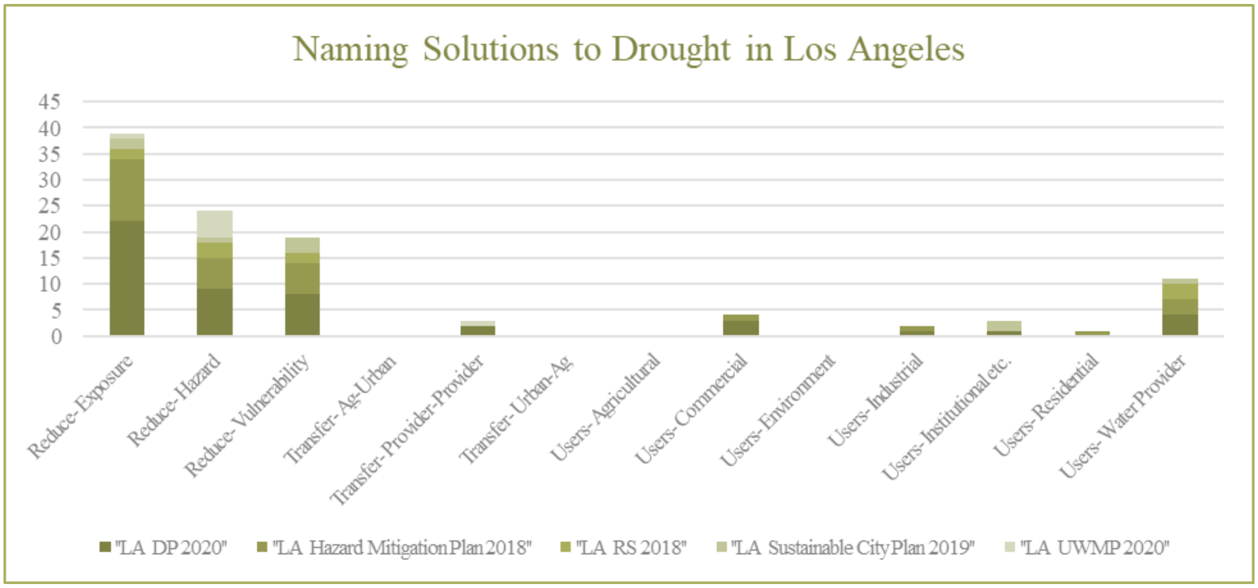

Figure 72. The number of instances each Naming Solutions code was found within Los Angeles' network of plans.

5.1.22 San Francisco, United States

San Francisco makes sense of drought primarily by being informed from past drought Events, followed most closely by a Scientification understanding (Figure 73). The problem of drought is understood as driven by Climate Change, with concern for Environmental impacts as well (Figure 74). The city notes the intersection between drought and other disasters, such as wildfires, earthquakes, and subsidence, as well as its impacts on urban forests. The solutions are again in the order of Reduce- Exposure, Reduce- Hazard, and Reduce- Vulnerability (Figure 75).

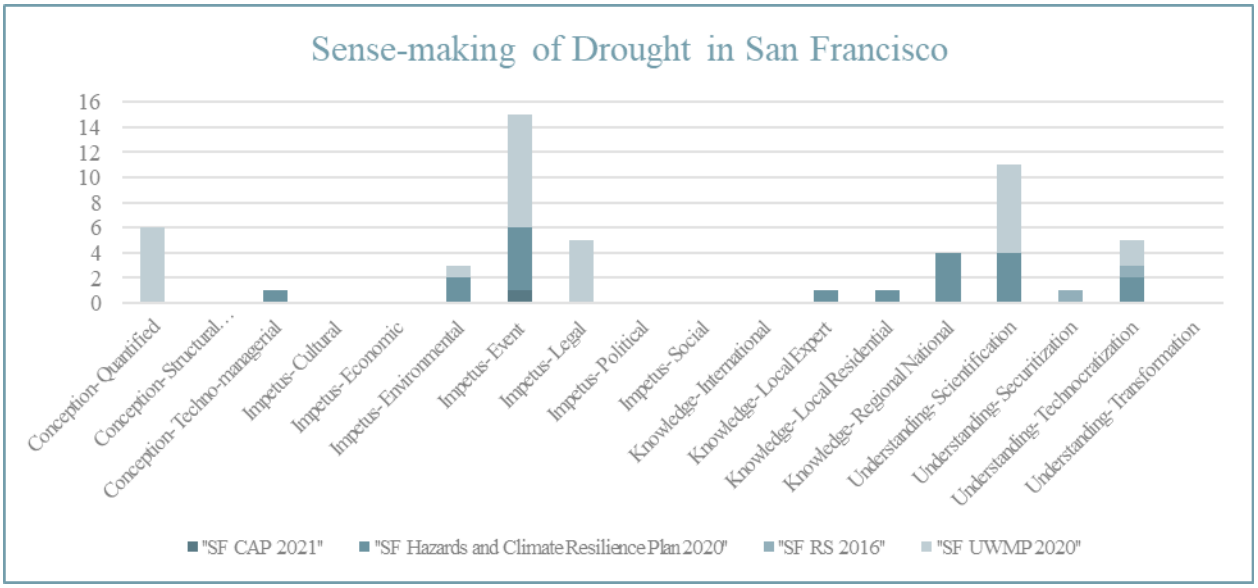

Figure 73. The number of instances each Sense-Making code was found within San Francisco's network of plans.

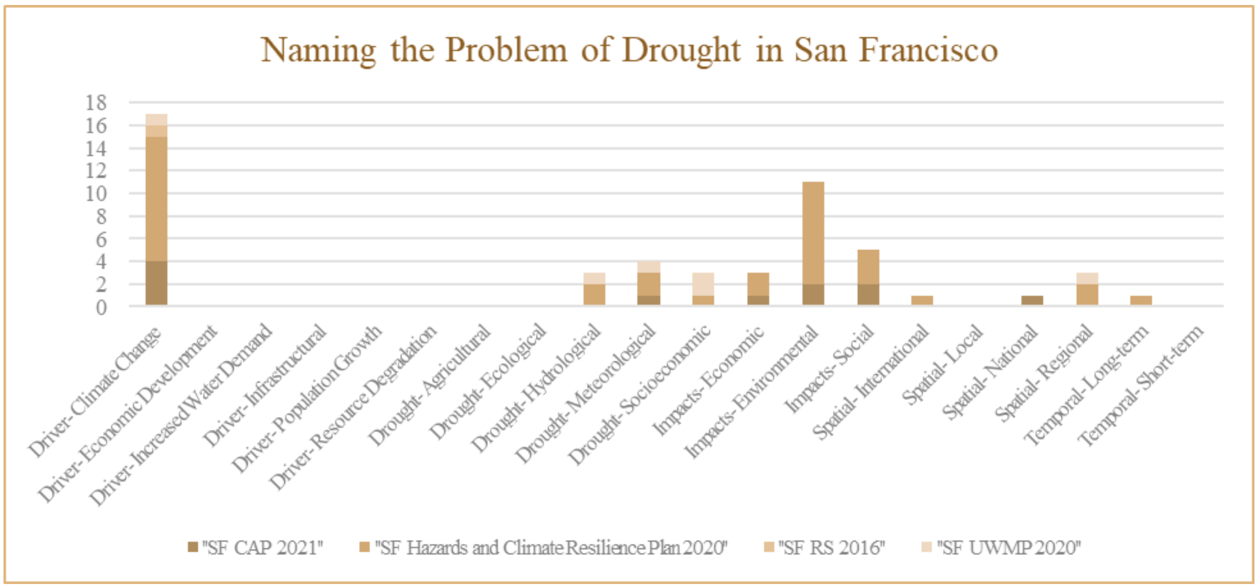

Figure 74. The number of instances each Naming the Problem code was found within San Francisco's network of plans.

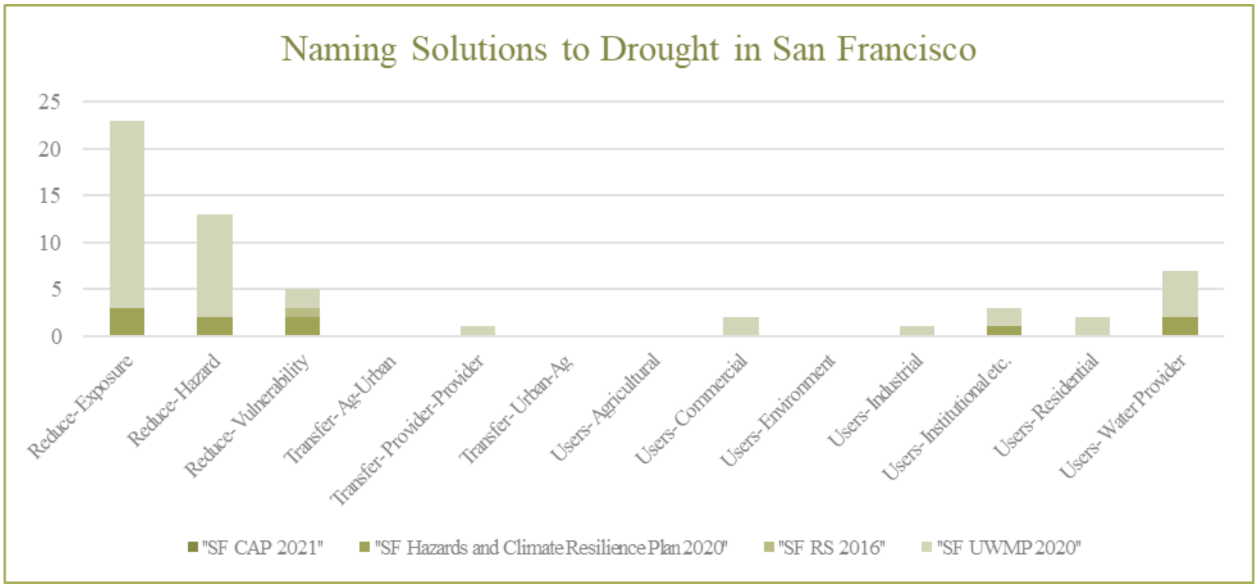

Figure 75. The number of instances each Naming Solutions code was found within San Francisco's network of plans.

5.1.23 Boulder, Colorado, United States

Making sense of drought in Boulder occurs through the impetus of past drought Events, with few occurrences of other sense-making codes (Figure 76). Despite this, the city's DP says that the city is not anticipated to experience many droughts into the future ("Boulder DP 2022"). Boulder names the problem of drought according to Environmental and Economic impacts, along with Climate Change (Figure 77). More than other solutions, Boulder includes Reduce- Exposure codes (Figure 78). Given that the city has a Water Efficiency Plan, this makes sense; however, not much text within the Water Efficiency Plan itself was coded, since the actions in that plan were not specific to drought conditions or drought response.

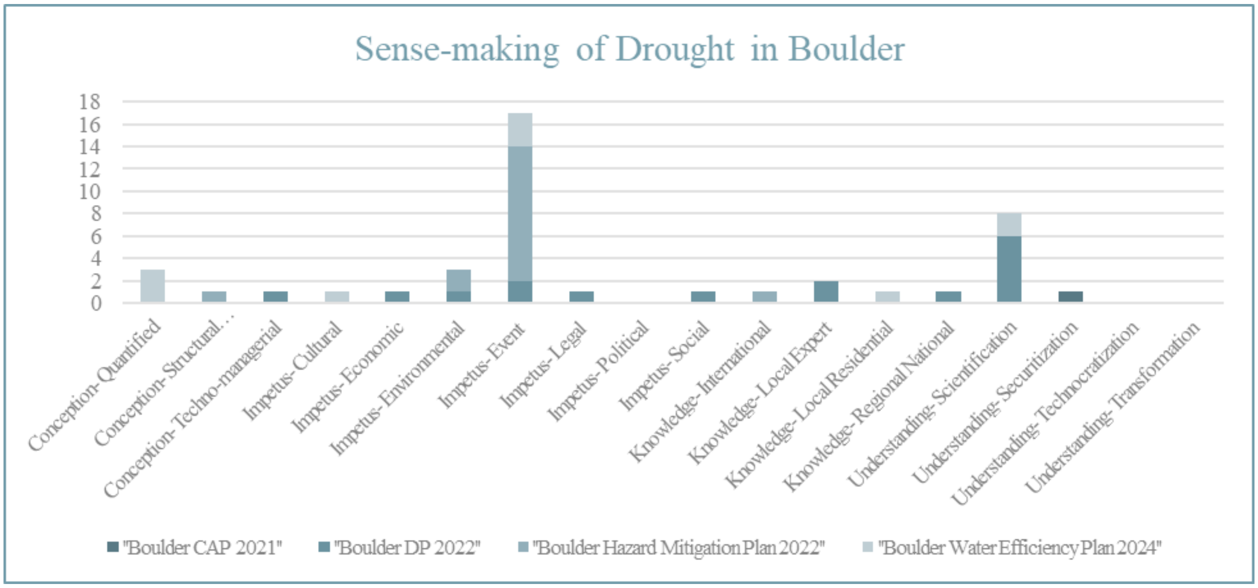

Figure 76. The number of instances each Sense-Making code was found within Boulder's network of plans.

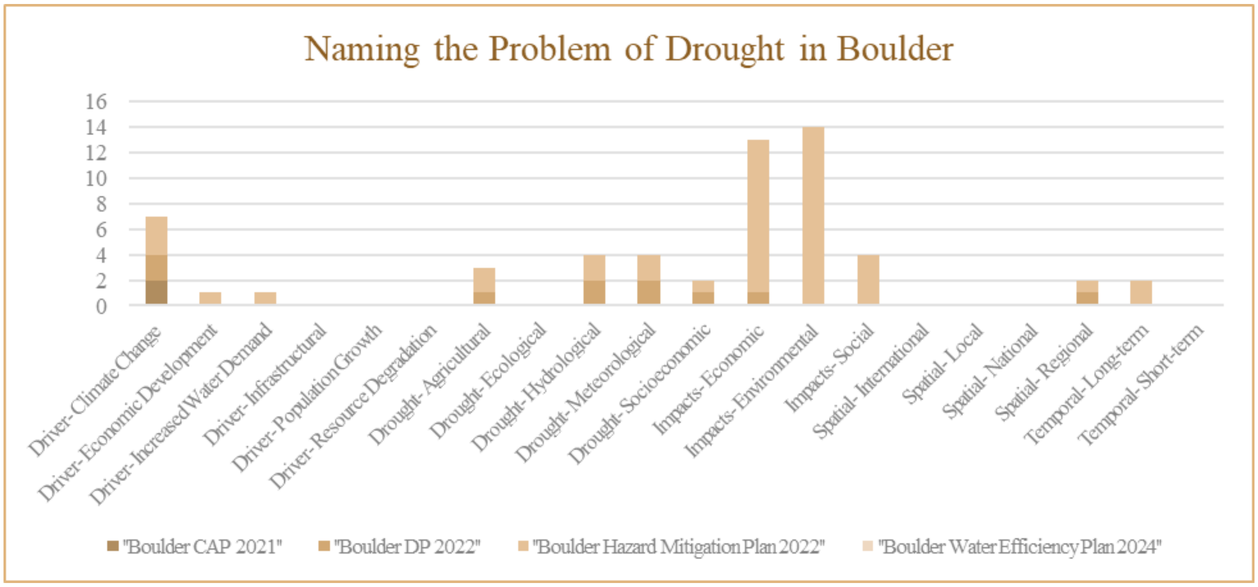

Figure 77. The number of instances each Naming the Problem code was found within Boulder's network of plans.

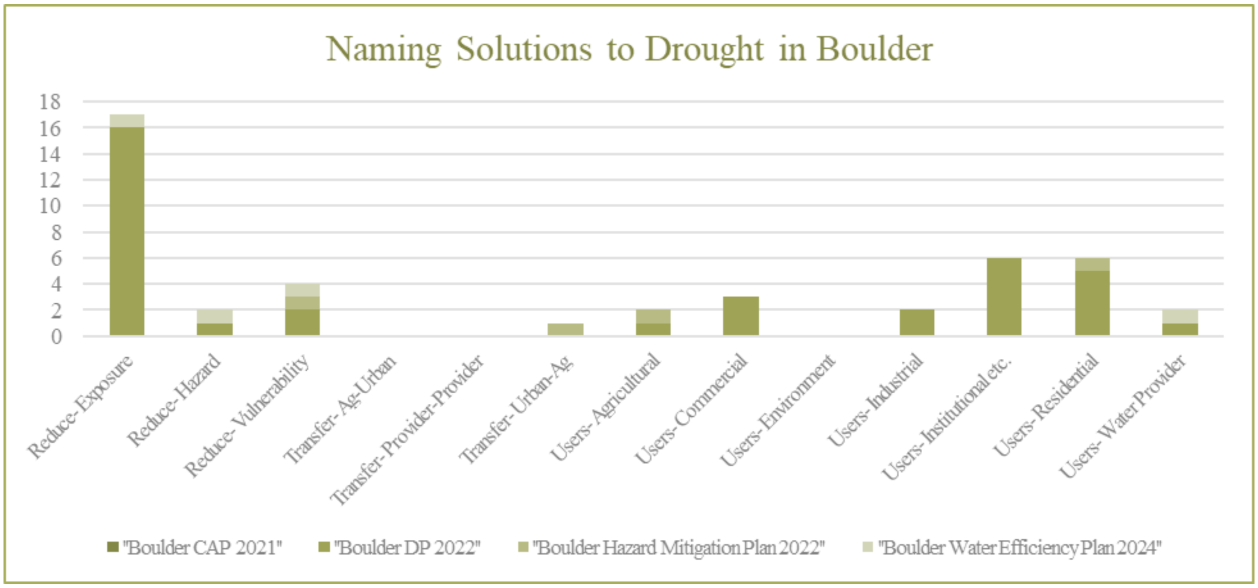

Figure 78. The number of instances each Naming Solutions code was found within Boulder's network of plans.

5.1.24 Atlanta, Georgia, United States

Atlanta has a lot of concern about water efficiency but not in connection to drought or water scarcity. Thus, there is low coding prevalence in the sense-making and naming the problem categories. Event and Legal impetuses are mentioned slightly more than other sense-making codes (Figure 79), whilst Climate Change is the most frequent naming the problem code (Figure 80). Reduce- Exposure is the most prevalent solution code, with most actions within that coded text focusing on outdoor water restrictions (Figure 81).

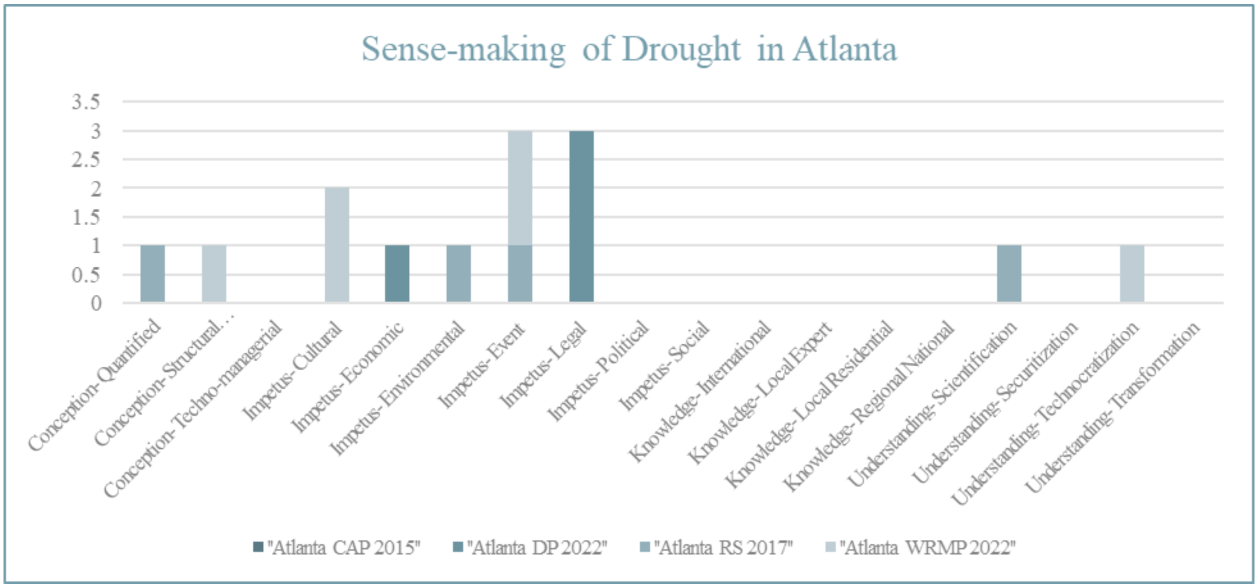

Figure 79. The number of instances each Sense-Making code was found within Atlanta's network of plans.

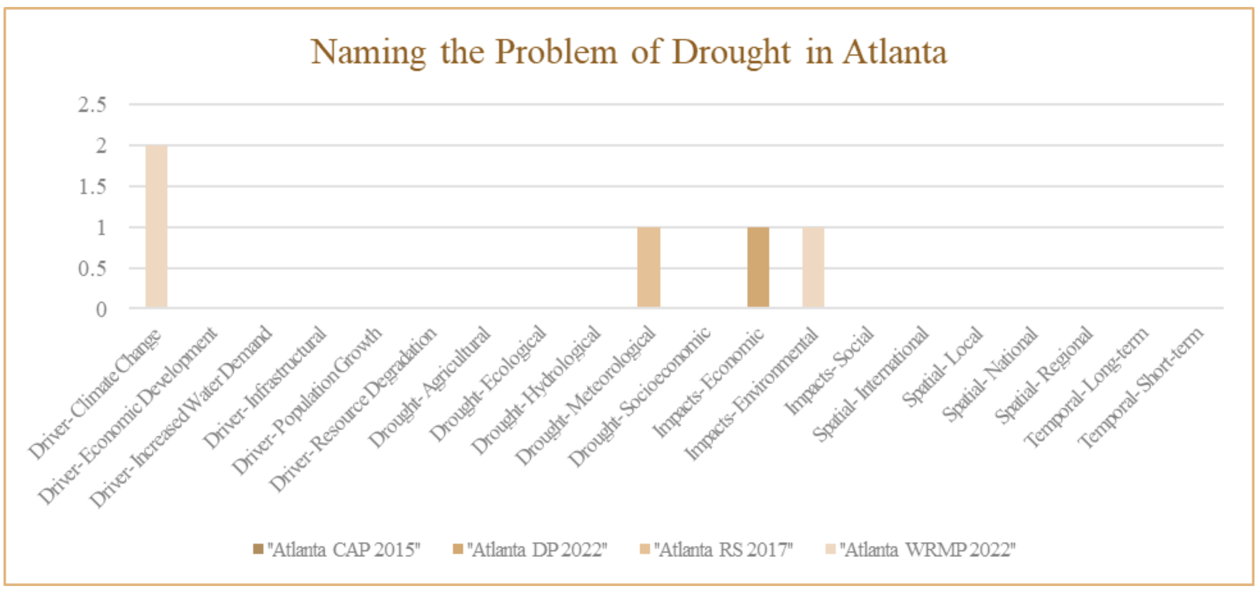

Figure 80. The number of instances each Naming the Problem code was found within Atlanta's network of plans.

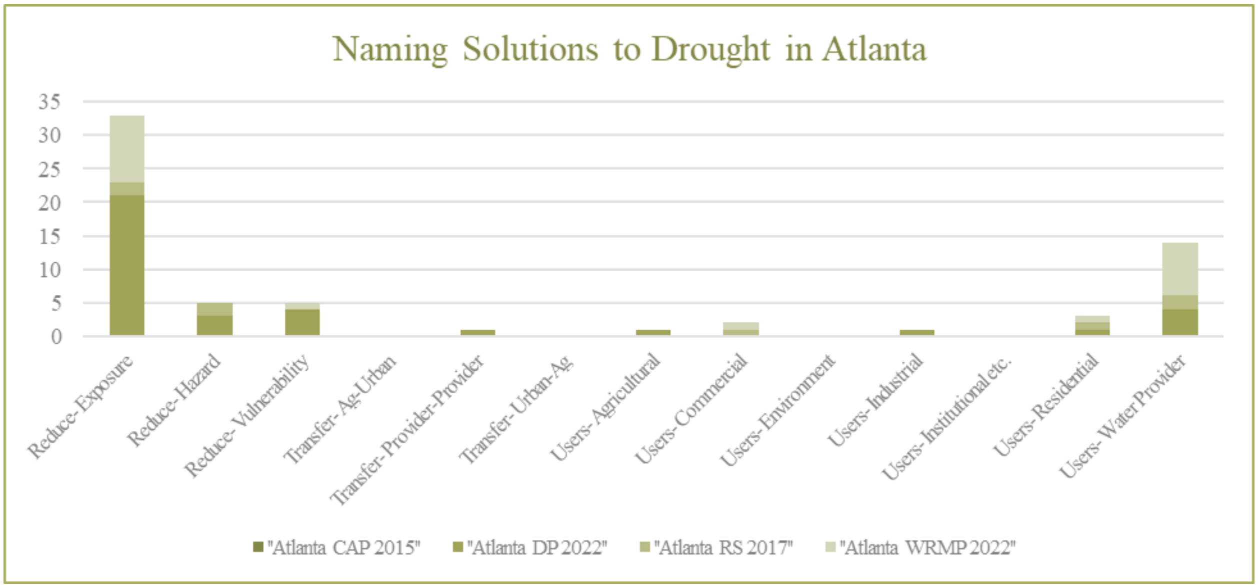

Figure 81. The number of instances each Naming Solutions code was found within Atlanta's network of plans.

5.1.25 Honolulu, Hawaii, United States

Like other cities in this cohort, Honolulu has low appearance of coding within the sense-making and naming the problem codes. A Securitization understanding and input of Local Expert knowledge help Honolulu make sense of drought, along with Economic, Event, Legal, and Social impetuses for planning (Figure 82). Climate Change is named as the primary of driver of drought, supplemented with Hydrological and Socioeconomic drought definitions and acknowledgment of Environmental impacts (Figure 83). The City has numerous Reduce- Exposure solutions to drought, and several instances of the Reduce- Vulnerability and Reduce- Hazards codes as well (Figure 84).

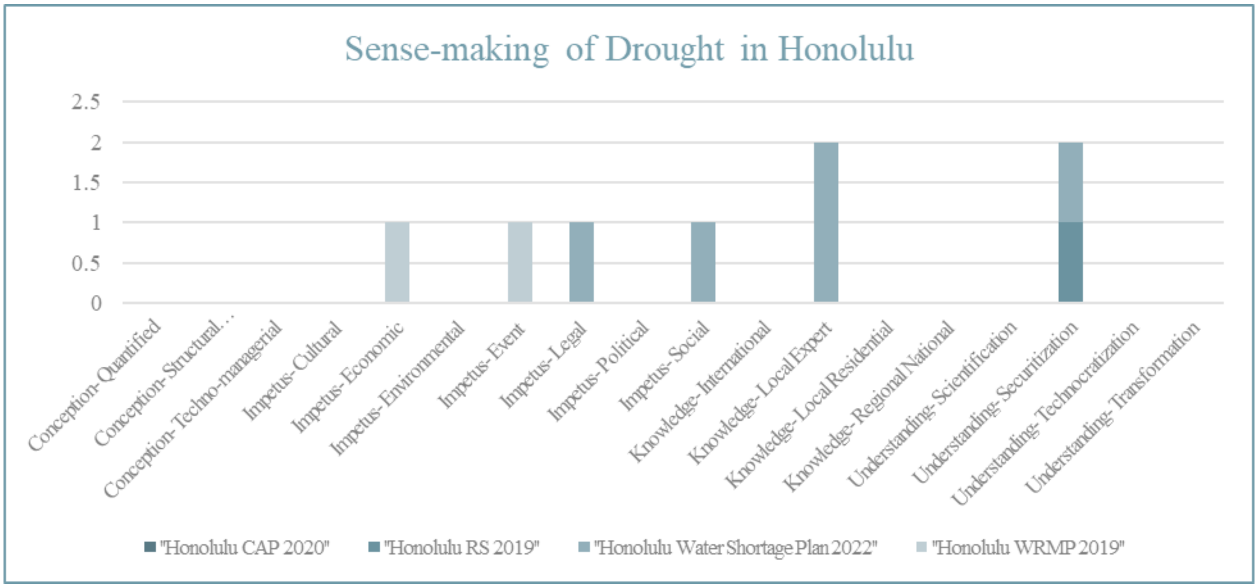

Figure 82. The number of instances each Sense-Making code was found within Honolulu's network of plans.

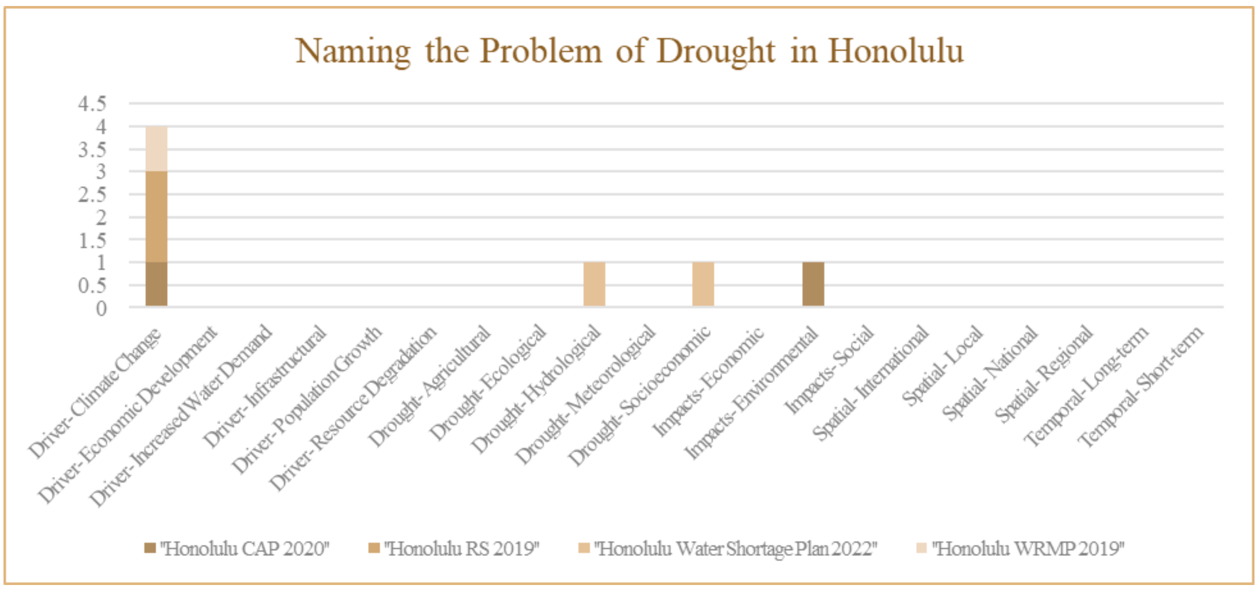

Figure 83. The number of instances each Naming the Problem code was found within Honolulu's network of plans.

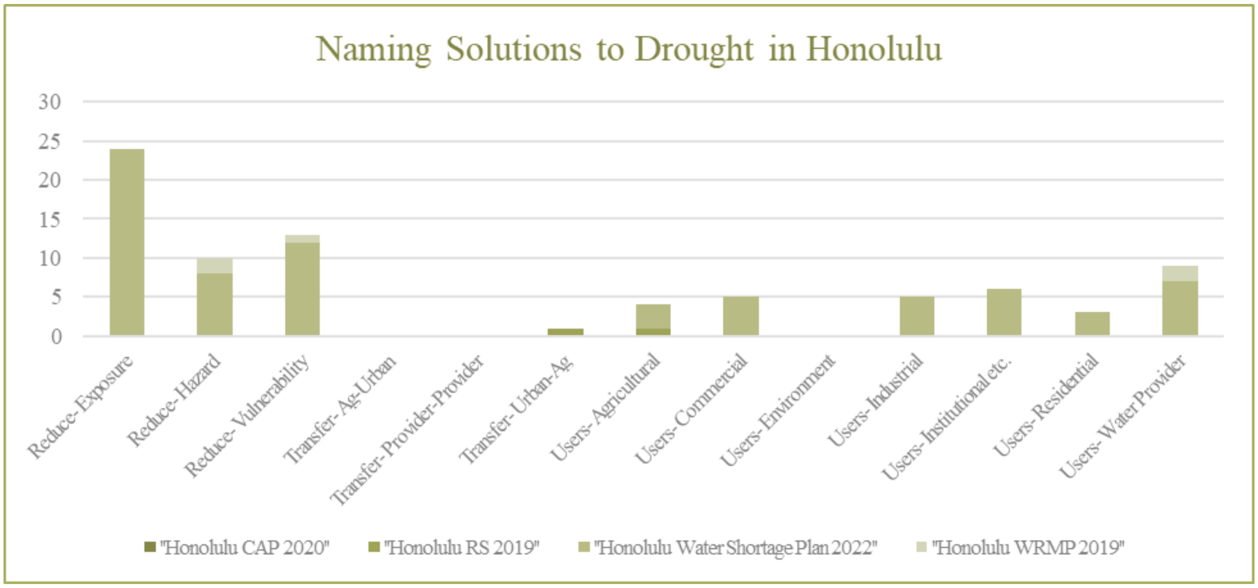

Figure 84. The number of instances each Naming Solutions code was found within Honolulu's network of plans.

5.1.26 Portland, Oregon, United States

Portland has relatively low coding prevalence across all codes. The most frequent code within sense-making was Impetus- Event (Figure 85). Naming the problem of drought is done according to a Hydrological definition of drought more than other codes (Figure 86). Reduce- Hazard is the most frequent solution code (Figure 87). Generally, Portland's plans describe very proactive water management, including annual drought forecasts and retrospectives to prepare for and learn from each season of potential drought. The regularity of these plans may contribute to an operational understanding of drought in which it is a self-evident issue requiring little framing, potentially explaining the low prevalence of sense-making and naming the problem codes.

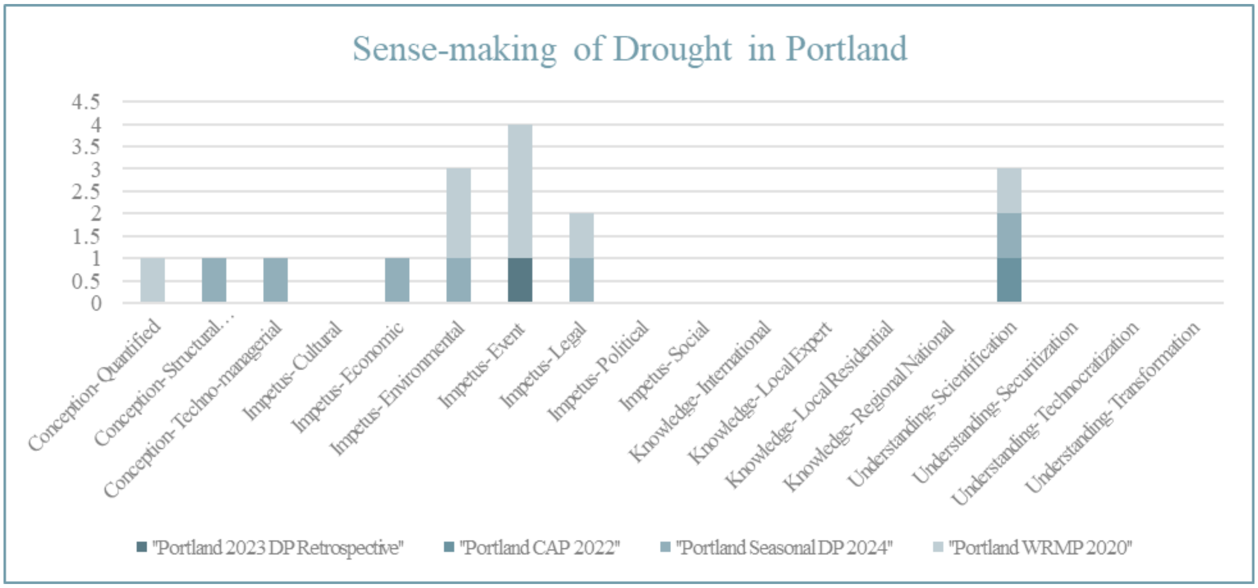

Figure 85. The number of instances each Sense-Making code was found within Portland's network of plans.

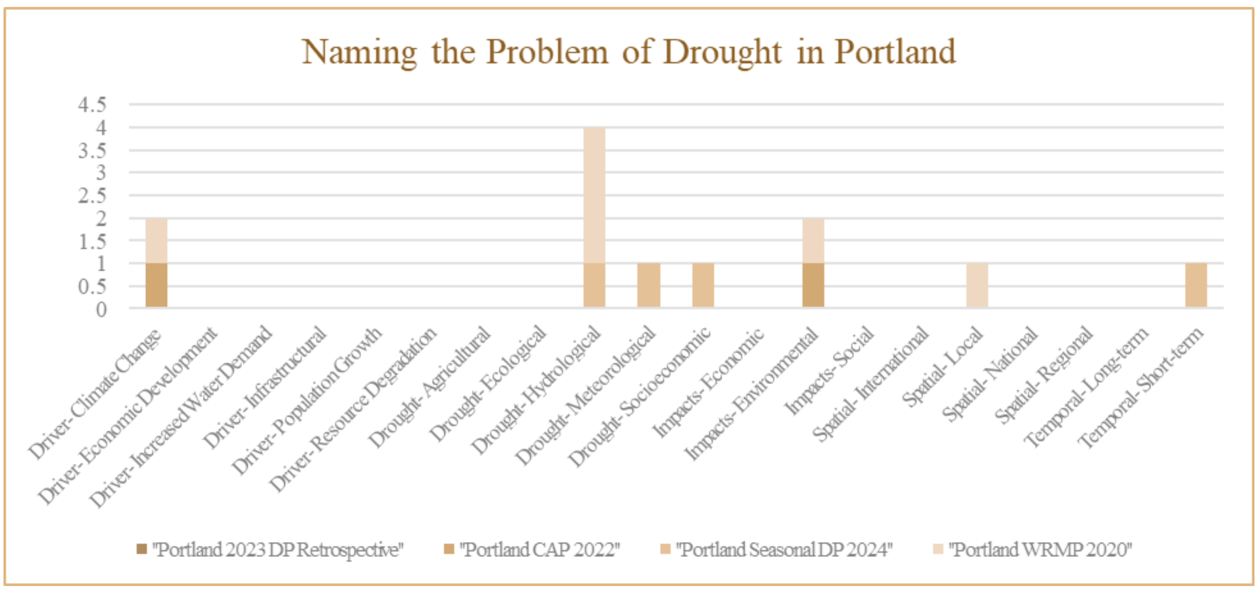

Figure 86. The number of instances each Naming the Problem code was found within Portland's network of plans.

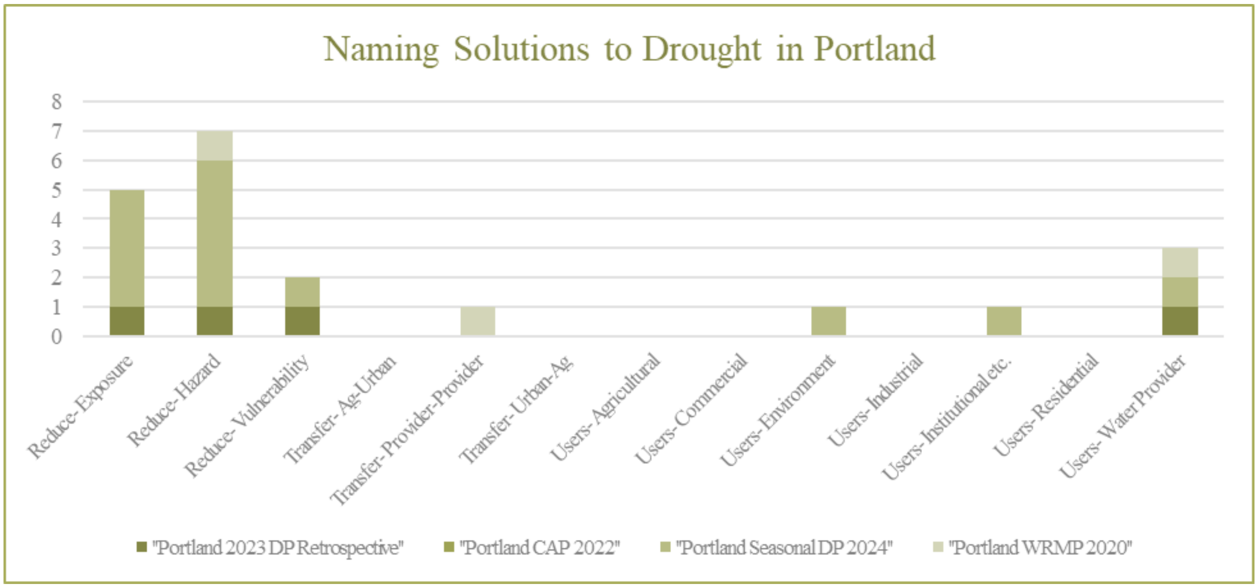

Figure 87. The number of instances each Naming Solutions code was found within Portland's network of plans.

5.1.27 Austin, Texas, United States

Texas, like California, has state-level requirements for water providers to write drought plans (Texas Water Code, Section 11.1272; and Texas Administrative Code, Title 30, Chapter 288). Texas drought plans are also adopted by each city's Council in order to formally authorize drought management authorities among the water provider and city departments. As a result, there is some uniformity to the Texas city drought plans, yet different results from the coding scheme. All have Reduce- Exposure as the highest solution code, the content of which is largely about water conservation via reducing outdoor water use.

Austin makes sense of drought principally through the impetus of past drought Events (Figure 88). The prevalence of this code is so high, especially in comparison to other codes in this category, in part because the Hazard Mitigation Plan describes nine past drought events in detail ("Austin Hazard Mitigation Plan 2021"). Climate Change features as the leading driver of drought across the naming the problem codes, and the three types of impacts are all discussed (Figure 89). The Hazard Mitigation Plan provides reason for this as well, as the drought section features a listing of the impacts from past droughts. Reduce- Exposure makes up the most coding within the solution section (Figure 90).

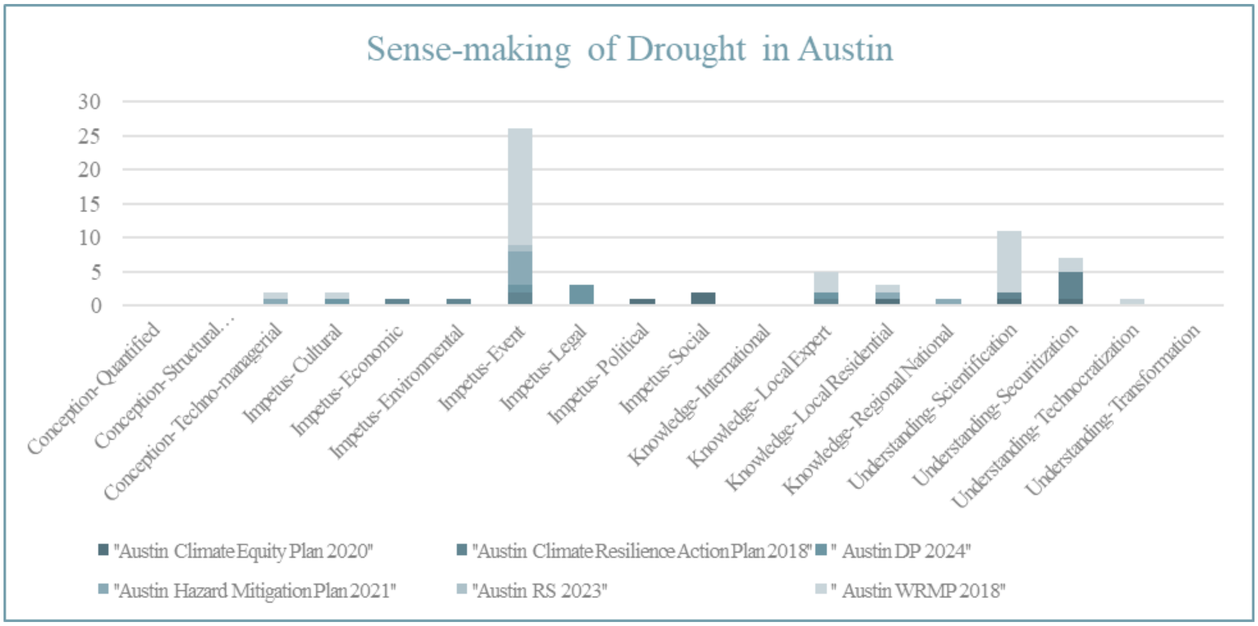

Figure 88. The number of instances each Sense-Making code was found within Austin's network of plans.

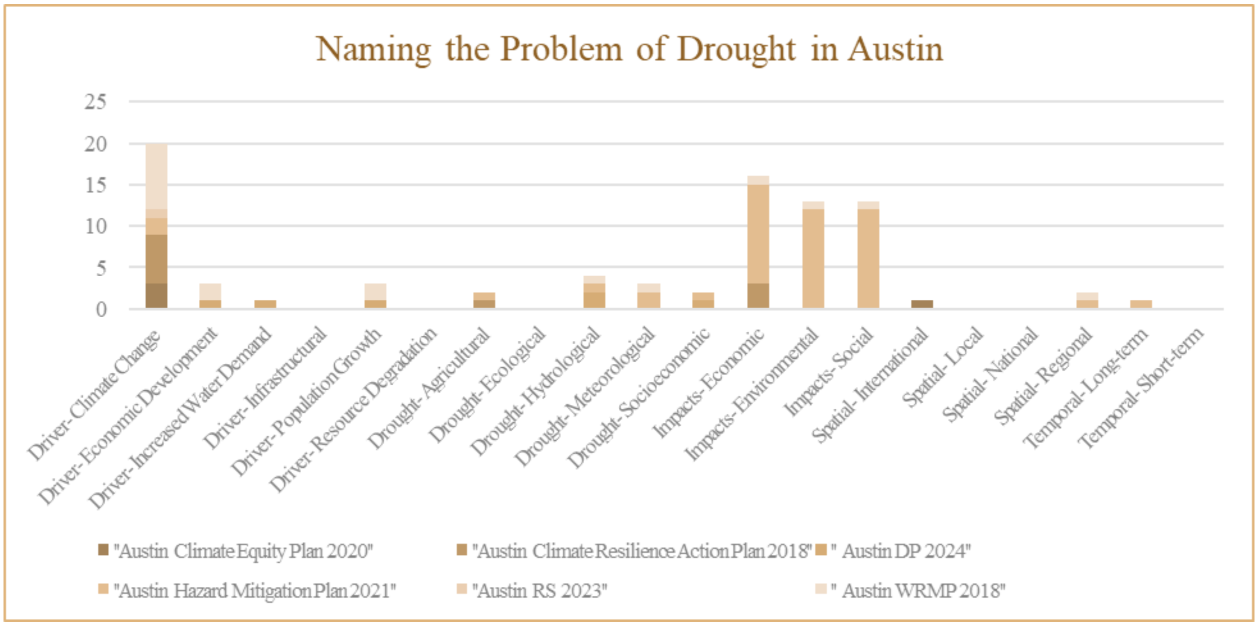

Figure 89. The number of instances each Naming the Problem code was found within Austin's network of plans.

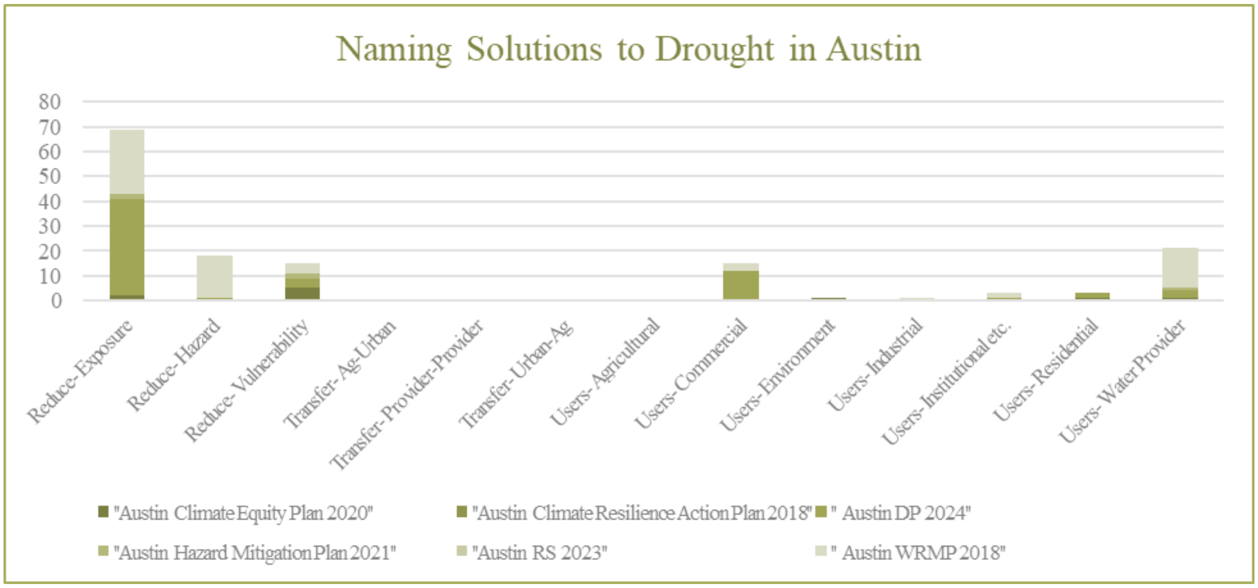

Figure 90. The number of instances each Naming Solutions code was found within Austin's network of plans.

5.1.28 Dallas, Texas, United States

The City of Dallas has low prevalence of sense-making (Figure 91) and naming the problem codes (Figure 92). Reduce- Exposure is the main solution code (Figure 93). Reduce- Vulnerability also has several occurrences, covering the gambit of themes within this code, from landscape conversions, to water rates, to water audits.

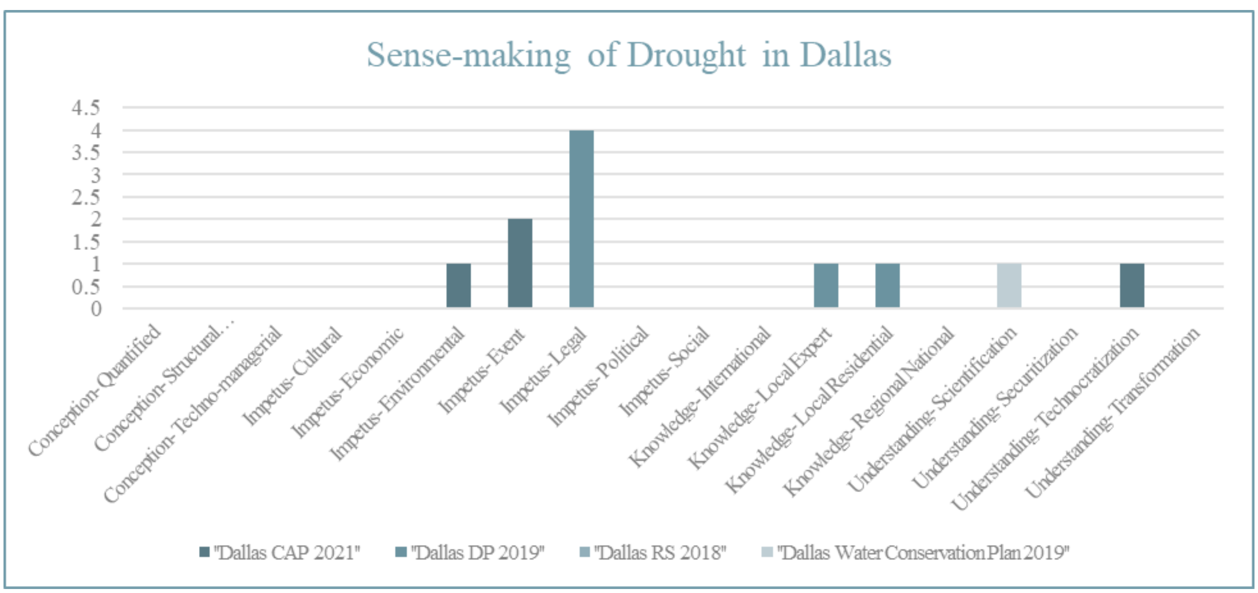

Figure 91. The number of instances each Sense-Making code was found within Dallas' network of plans.

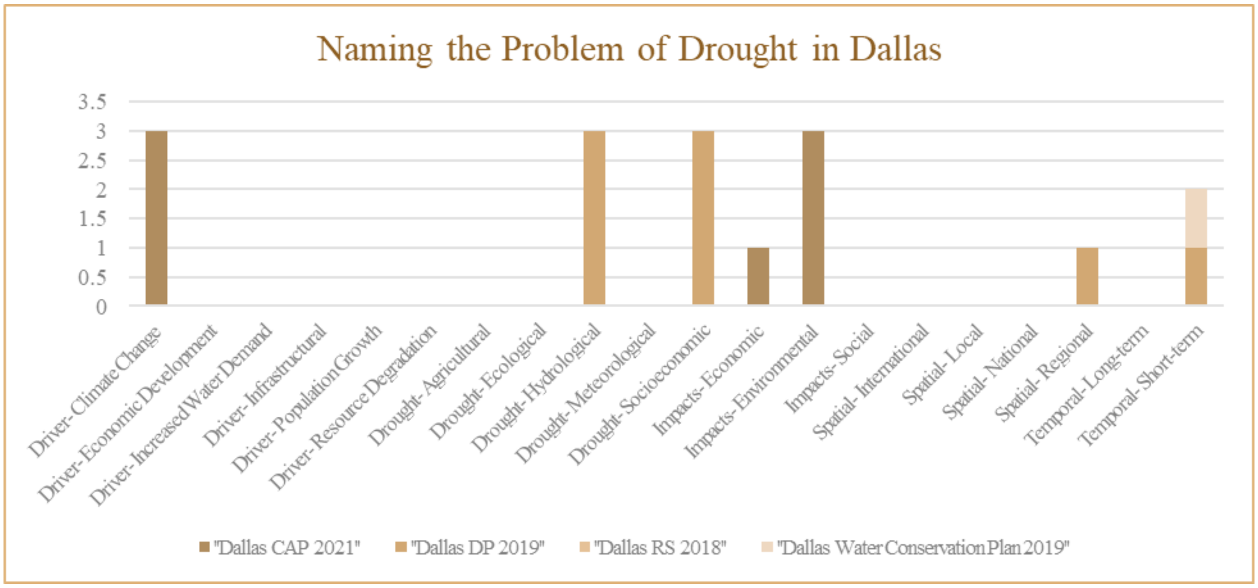

Figure 92. The number of instances each Naming the Problem code was found within Dallas' network of plans.

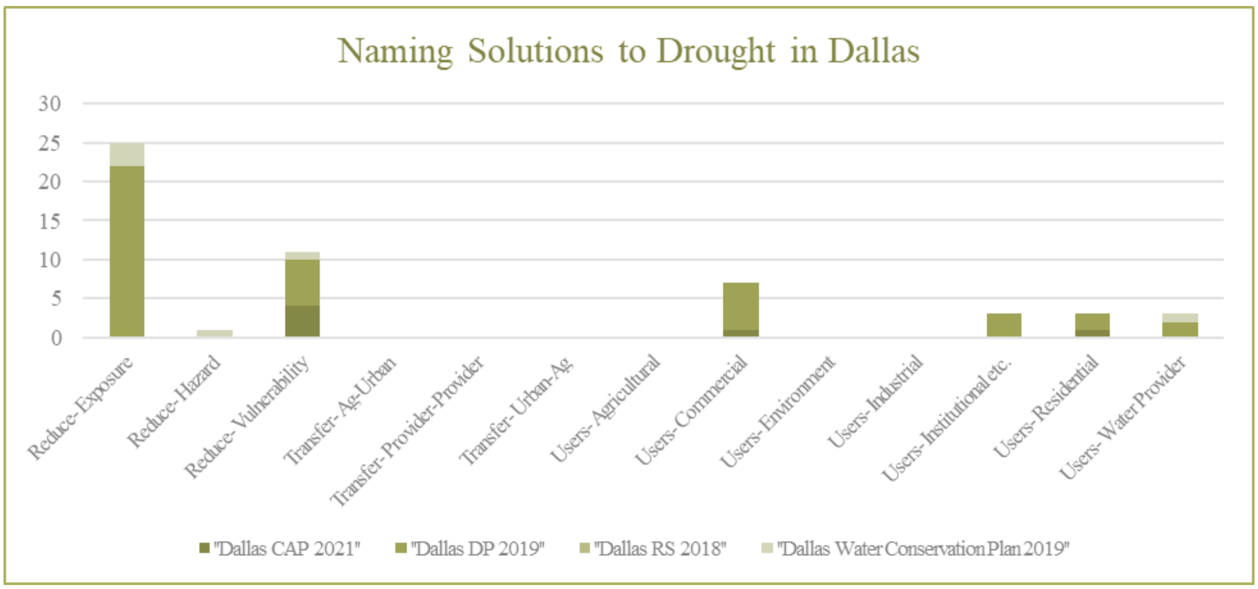

Figure 93. The number of instances each Naming Solutions code was found within Dallas' network of plans.

5.1.29 El Paso, Texas, United States

El Paso primarily makes sense of drought through an Environmental impetus (Figure 94). In doing so, the city mostly acknowledges drought as a fact of life in an arid, desert city. Perhaps because of this, the main naming the problem code present is a Socioeconomic definition of drought (Figure 95), wherein demand exceeding supply is a problem more than rainfall or water storage levels. In the solutions category, Reduce- Exposure is still the most frequent code, but Reduce- Hazard also appears with frequency and the Water Provider is attributed responsibility more than other users (Figure 96). Within Reduce- Hazards, El Paso discusses most types of water augmentation, including consideration of buying agricultural water rights or subsidizing farmers' water efficiency improvements to gain the excess supply.

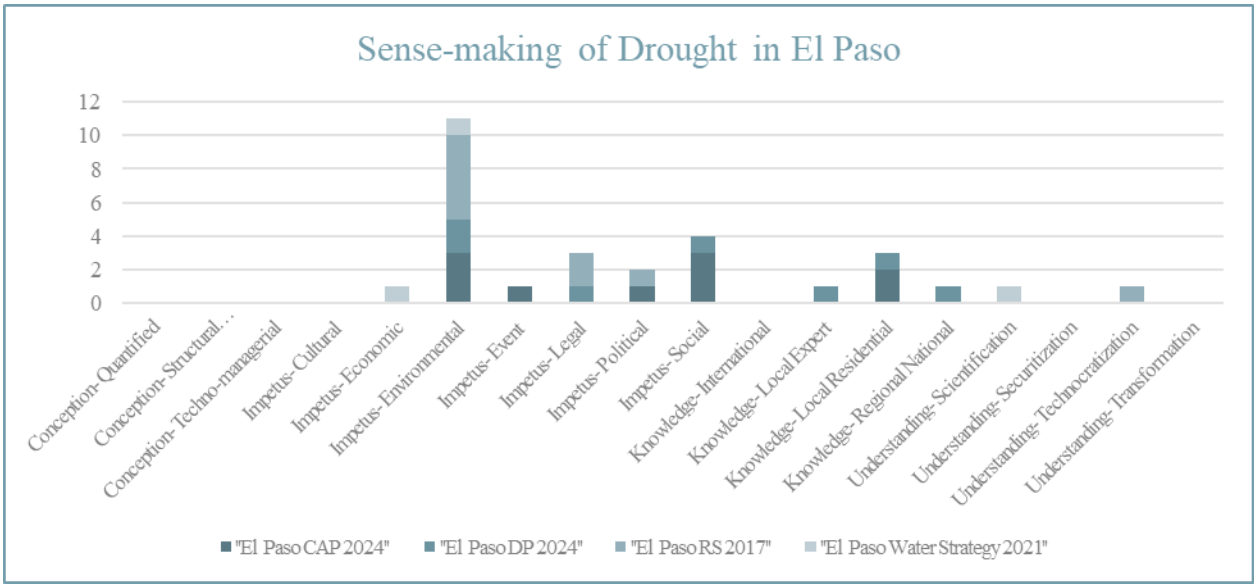

Figure 94. The number of instances each Sense-Making code was found within El Paso's network of plans.

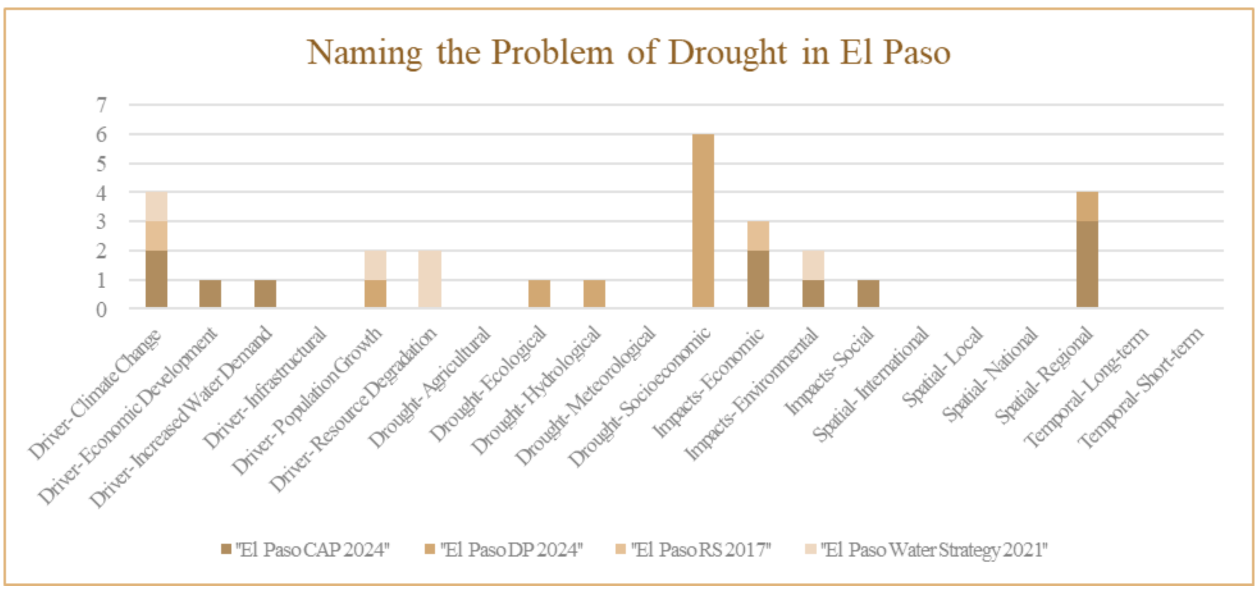

Figure 95. The number of instances each Naming the Problem code was found within El Paso's network of plans.

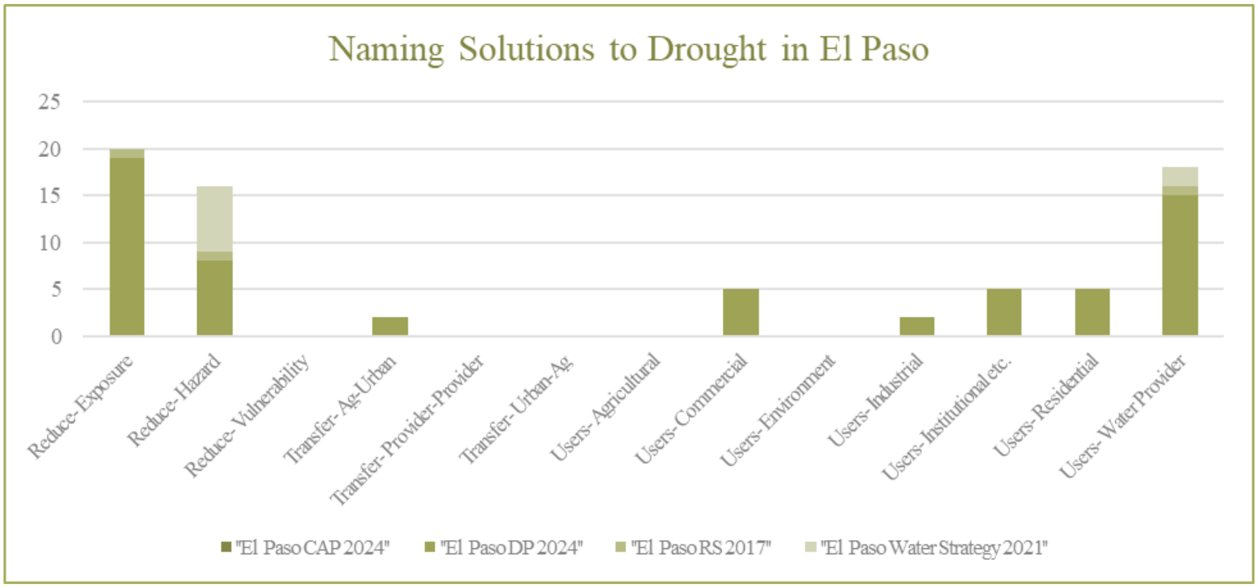

Figure 96. The number of instances each Naming Solutions code was found within El Paso's network of plans.

5.1.30 Houston, Texas, United States

Houston, despite being more commonly known for its flooding problems, makes sense of drought mainly through Impetus- Event (Figure 97). Within naming problems, Climate Change is recognized as the primary driver (Figure 98). Solutions to drought are less prevalent in Houston compared to the other Texas cities, though Reduce- Exposure is still most frequent (Figure 99).

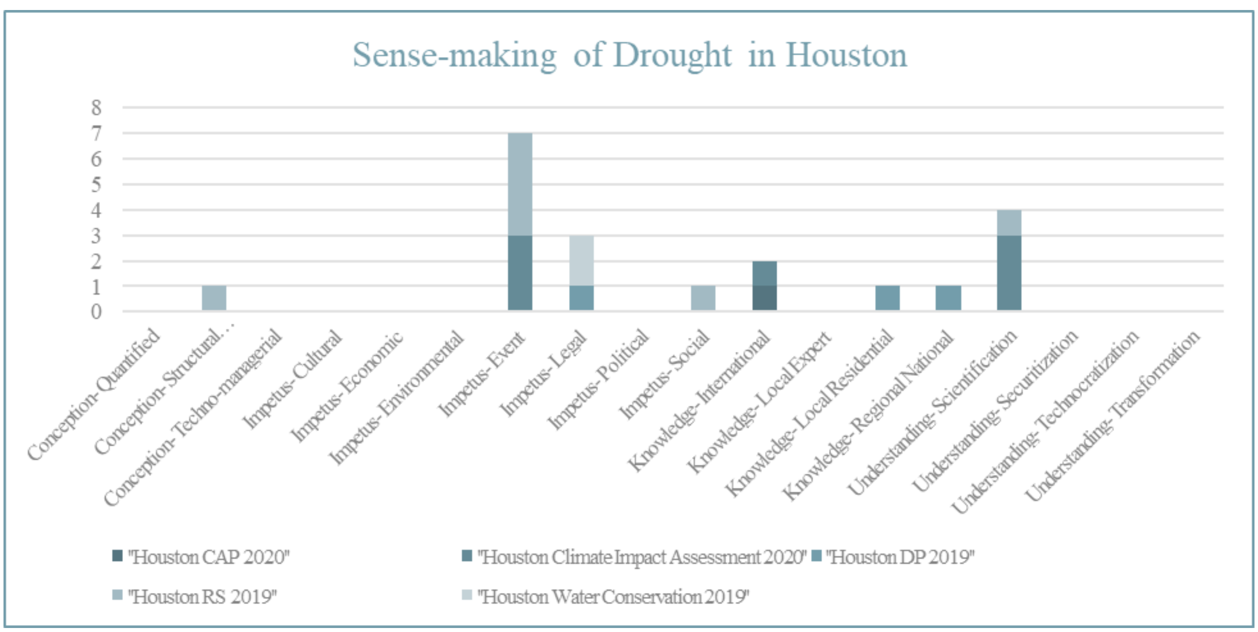

Figure 97. The number of instances each Sense-Making code was found within Houston's network of plans.

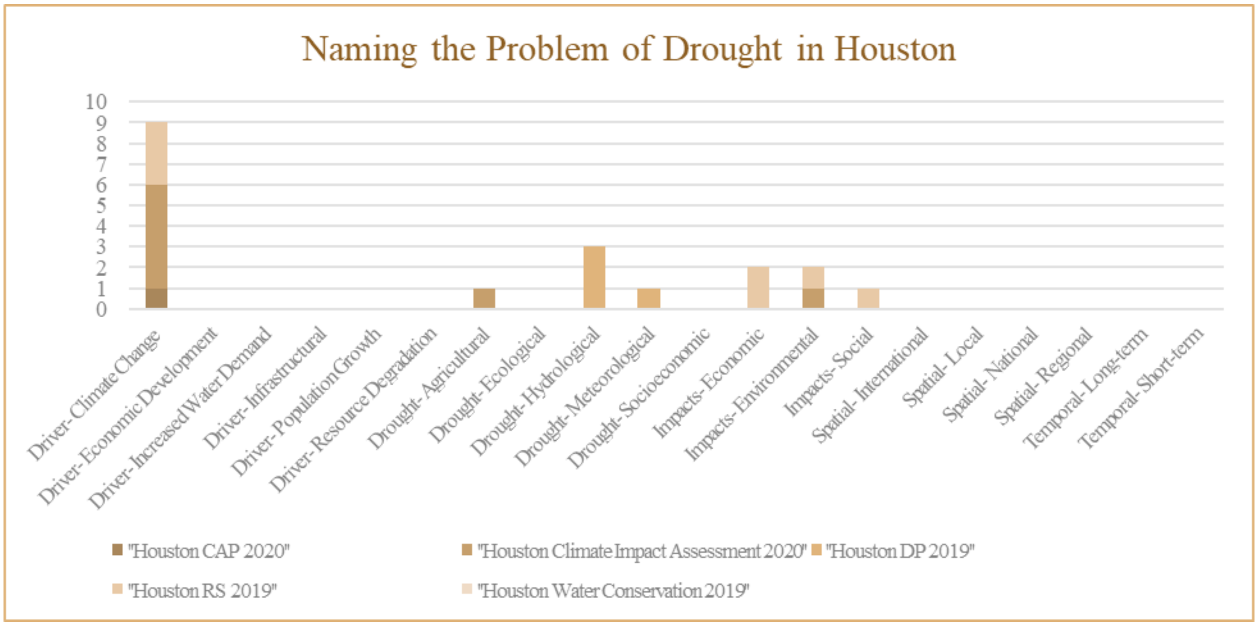

Figure 98. The number of instances each Naming the Problem code was found within Houston's network of plans.

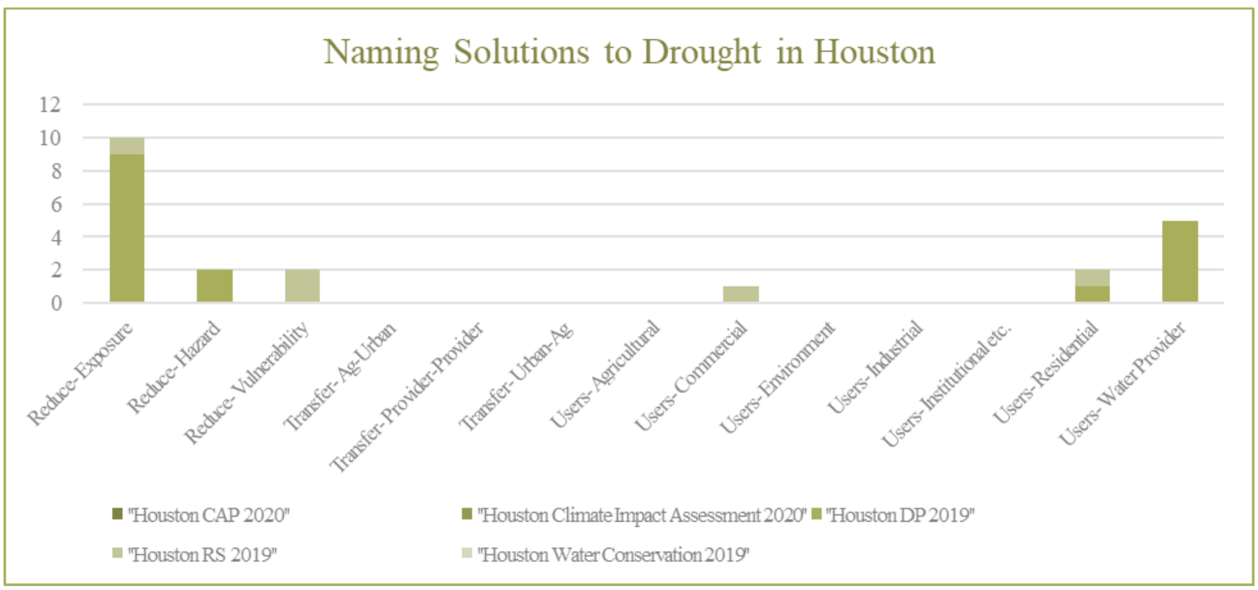

Figure 99. The number of instances each Naming Solutions code was found within Houston's network of plans.

5.2 Results for RQ2: Do issues of urban-rural water allocation emerge in urban planning processes?

A combination of the number of times certain codes appeared, word cloud generation through NVivo to show topic prevalence, and close reading of the content coded reveals that issues of urban-rural water allocation do emerge in urban planning processes but are mostly related to concern over agricultural impacts and users rather than interest in taking their supplies. Figure 100 shows the instances of coding that relate to urban-rural water allocation.

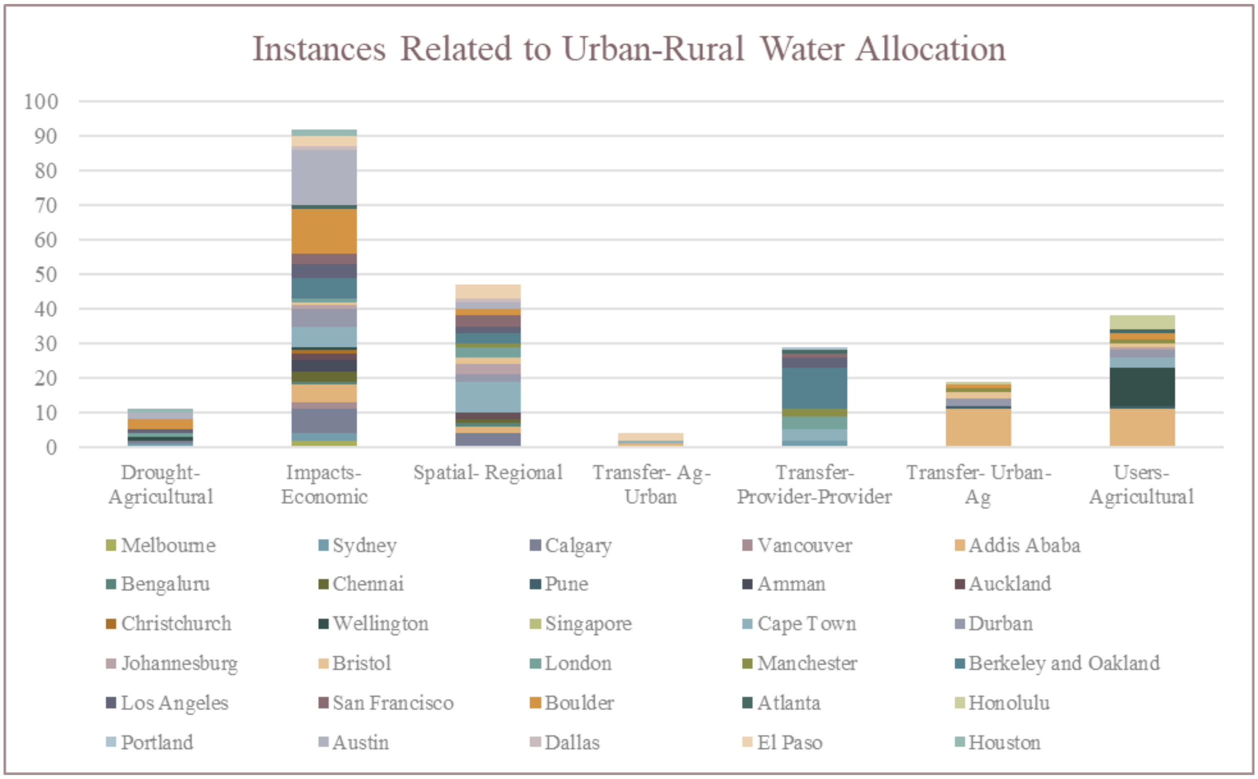

Figure 100. Coding occurrences relevant to urban-rural water allocation issues across all cities' plans.

Agricultural drought is a definition of drought mentioned very seldomly in city plans. Of the 11 instances of the agricultural drought code, only seven use it in an operational manner (i.e., using soil moisture deficit as a drought trigger), while the other four instances just acknowledge that it is a possible type of drought definition. Thus, the cities in this study are not necessarily concerned with agricultural drought by definition—even the ones that use it operationally use it as just one of many metrics—but there is evidence that they are concerned about agricultural impacts and users.

Agricultural impacts and food security were coded under Impacts- Economic and are a major sub-theme of this code. The NVivo-generated word cloud for Impacts- Economic (Figure 101) shows agriculture as the nineth most-mentioned word: "agricultur(e/al)" appears in 26 of the 92 codes for economic impacts, "food" in 21, "crops" in 11, and "irrigation" in nine. More substantively, it is the most-discussed industry and water user, higher than businesses (23), community (16), industry (16), or the public (10) in this code. Concern for agricultural impacts is present within 15 of the studied cities. However, agriculture is not often discussed within the Spatial- Regional code (Figure 100). Cities are more concerned with general issues of catchment management and water allocation within the Spatial- Regional code.

Figure 101. Word cloud of the 30 most frequent words within the Impacts- Economic code, which demonstrates a prevalent concern about agricultural impacts.

The most common type of water transfer described is between formal water providers through emergency sharing agreements or similar tools in the Transfer- Provider-Provider code. The Transfer- Ag-Urban code only appears four times; one from Cape Town, acknowledging that an agricultural transfer helped in the 2015-2019 Drought; two from El Paso, noting that buying water rights or subsidizing farmer's water use efficiency could be a water supply option into the future; and one from Addis Ababa, noting that the needs of small-scale farmers need to be considered in future drought planning. Thus, only one of these cities, El Paso, is actively considering an agricultural water transfer in the future. In contrast, seven cities (Addis Ababa, Boulder, Bristol, Durban, Honolulu, Manchester, and Pune) are concerned with actively supporting farmers during drought, either through a direct water transfer, financial or technical aid, or through means of proliferating urban agriculture within municipal bounds. These discussions make up the bulk of the Transfer- Urban-Ag code.

5.3 Results for RQ3: Does the framing of drought impact chosen drought management strategies?

In answering this research question, it is first worth noting the major strategies that emerged within each of the three drought management codes, as they were broad categories. Tables 6, 7, and 8 show the strategies which are prominent in the coded text of each of the Reduce- categories, generated via the word cloud feature of NVivo and then manually checked and aggregated according to the proper meanings of each term (i.e., “leak” and “leakage” were combined, as they entail the same action, and generic terms (e.g., “water”) were removed). These are the number of occurrences of the words or topics within the coded text, and thus the counts can be higher than for the total number of coded instances, where coded text included repetition of the same word.

Reduce- Exposure contained initiatives that encourage water conservation and efficiency. Thus, the specific programmes that were prevalent under this coding are to drive down water use, with schemes to reduce outdoor water use being the most common. Notably, Rijke et al. (2014) include wastewater reuse and storm/rainwater harvesting under this category, arguing that these are not proper supply augmentation sources, as they entail more efficient use of the urban water cycle, rather than introducing new quantities of water into it. Sydney provides a description of these sources which justifies this as well, saying “[wastewater reuse] supply contribution during drought will be lower because water restrictions mean there will be less wastewater produced and available for treatment.” (“Sydney Water Strategy 2022”, p. 68). In other words, wastewater reuse is not a supply which grows endlessly with population growth, but an existing part of the urban water cycle which is generally uncaptured and subject to gains in use efficiency. Therefore, it is prominent in this category as well.

Table 6. The major specific strategies that were prevalent within the Reduce- Exposure coded text.

Reduce- Exposure Initiative	Count	Definition
Outdoor water use	325	Reducing irrigation, landscapes, outdoor water use or improving efficiency
Leaks	180	Repairing water system leaks and/or reduce water losses
Washing	158	Prohibitions on water use such as building cleaning, vehicle washing
Recycling	106	Wastewater recycling through potable or non-potable use
Reuse	103	Rainwater harvesting and stormwater reuse
Operational efficiency	89	Water provider operational efficiency, including pressure management
Education campaigns	78	Educational campaigns to encourage water conservation and efficiency in customers
Reduce water waste	47	Reducing water waste at the customer level (leaks or extraneous water use)
Pools	39	Prohibitions on pool filling or re-filling

Reduce- Hazard was about augmenting water supplies through new sources, more intensive use of existing sources like groundwater, and increased water storage. Table 7 shows that the traditional supply sources of groundwater, surface water, and increasing storage are more popular than the alternative source of desalination; however, desalination is more prevalent than some of the Reduce- Exposure and Reduce- Vulnerability water conservation strategies shown in Tables 6 and 8. Water reuse and recycling—considered by some as alternative supplies as well—as shown in Table 6 are also more prevalent than desalination. These points add nuance to emerging notions about the popularity of water supply augmentation from "alternative" supplies (Ghosh et al., 2022; Karimidastenaei et al., 2022; Li et al., 2022).

Table 7. The prevalent water supply sources identified within the Reduce- Hazard coded text.

Reduce- Hazard Supply Sources	Count
Groundwater supplies	215
Surface water supplies	158
Emergency supplies or transfers	132
Increased water storage	181
Desalination	96

Reduce- Vulnerability contained drought management strategies related to reducing total water demand over time, through pricing mechanisms, landscape transformations, metering, monitoring of drought indicators, and watershed protection. Pricing mechanisms were the most prevalent strategy within this category by far, followed by installing drought-tolerant landscaping, as shown in Table 8.

Table 8. The prevalent drought management strategies which appeared within Reduce- Vulnerability coded text.

Reduce- Vulnerability Strategies	Count
Water rates, tariffs, drought surcharges, etc.	168
Drought-tolerant landscaping	115
Meters	50
Environmental flows	49
Watershed protection	44
Monitoring	23

Similarity indices were calculated to determine correlation between codes, thus providing an indicator of whether codes were related to test whether issue framing (the Sense-making and Naming the Problem categories) influences resultant drought management strategies (the Reduces- codes). The cluster analysis feature within NVivo determines the similarities and differences between the coded content, calculating a similarity index using the Pearson correlation coefficient, where -1 indicates the least similarity and +1 indicates the most similarity. Codes with a Pearson correlation coefficient greater than 0.8 were considered to be significant, in line with similar studies (Sullivan et al., 2024; Sullivan & White, 2020; Taylor et al., 2021). These are displayed in Figure 102. Codes with a similarity index less than 0.8 are cut off for clarity, though many codes have some degree of correlation.

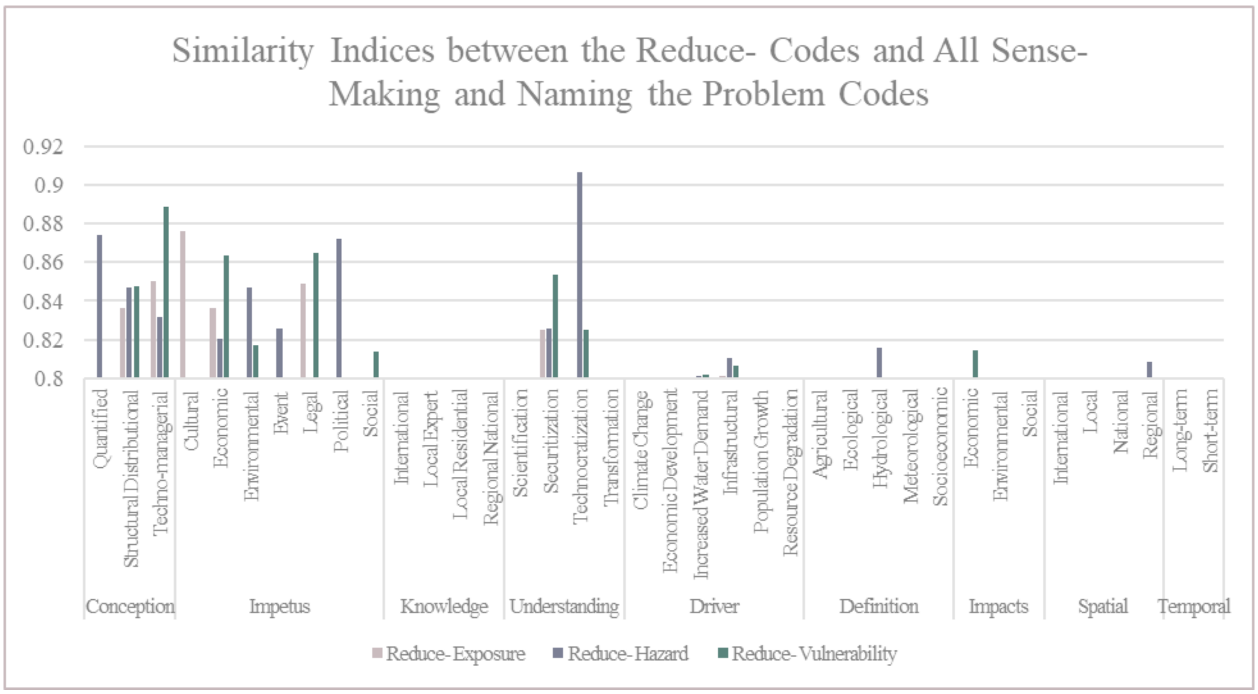

Figure 102. The Pearson correlation coefficients greater than 0.8 for Sense-making and Naming the Problem codes with similarity to Reduce- Exposure, Reduce- Hazard, and Reduce- Vulnerability.

Several codes have a significant similarity index with Reduce- Exposure: Cultural (0.88), Techno-managerial (0.85), Legal (0.85), Structural/Distributional (0.84), Impetus- Economic (0.84), Securitization (0.82), and Infrastructural (0.80). The codes with high similarity to Reduce- Hazard are Technocratization (0.91), Quantified (0.87), Political (0.87), Structural/Distributional (0.85), Impetus- Environmental (0.85), Techno-managerial (0.83), Impetus- Economic (0.82), Event

(0.82), Securitization (0.82), Infrastructural (0.81), Hydrological drought (0.82), and Regional scales (0.81). The codes with high similarity to Reduce- Vulnerability are Techno-managerial (0.89), Legal (0.87), Impetus- Economic (0.86), Structural/Distributional (0.85), Securitization (0.85), Technocratization (0.83), Impetus- Environmental (0.82), Social (0.81), Infrastructural (0.81), Impacts- Economic (0.81), and Increased Water Demand (0.80).

Each Reduce- code does have a unique code with the highest correlation of all: Reduce- Exposure and Cultural Impetus, Reduce- Hazard and Technocratization, and Reduce- Vulnerability and Techno-managerial. However, there are also overlaps in the correlating codes between the three categories. Figure 103 shows these overlaps more clearly, with five codes occurring across all three Reduce codes. Cultural Impetus is unique to Reduce- Exposure, while Hazard and Vulnerability have more than one code that is unique in correlation to that strategy.

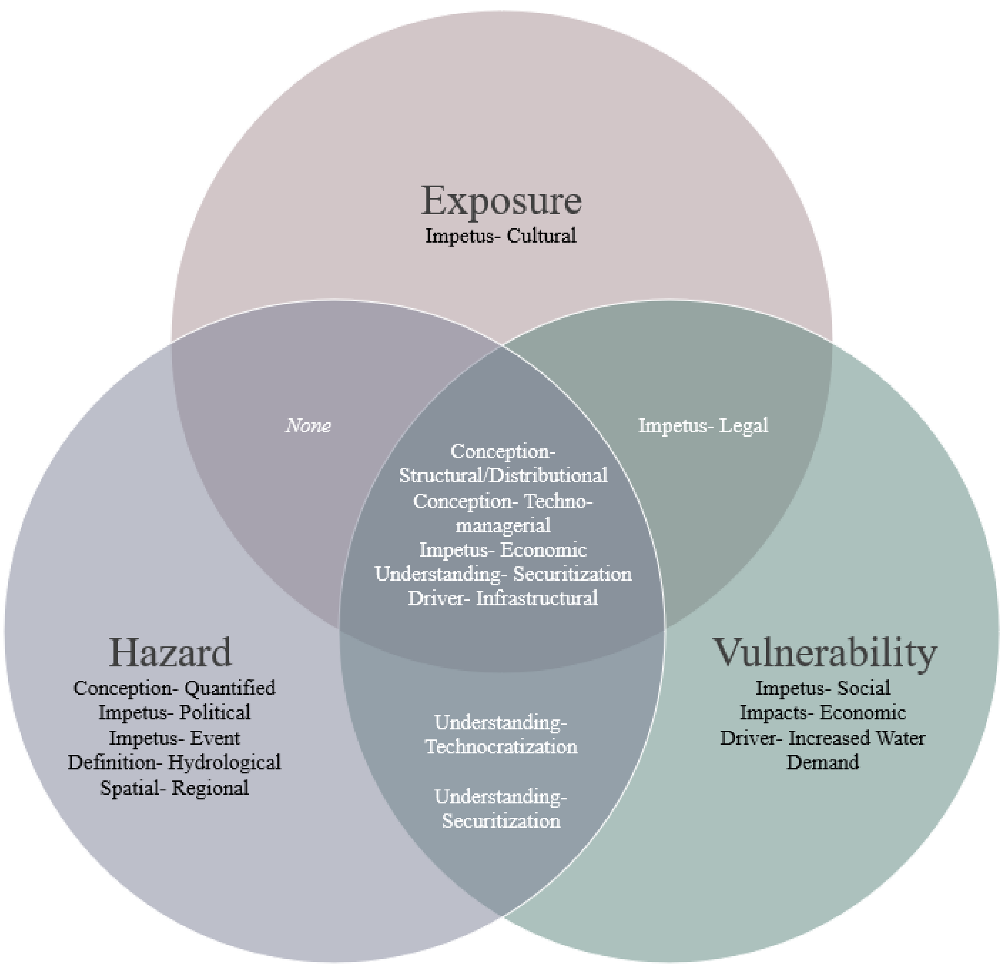

Figure 103. A Venn diagram showing the codes with overlapping similarity indices across the three Reduce codes.

These results indicate that several components of issue framing do influence resultant drought strategies. Numerous codes entail significant Pearson correlation coefficients, suggesting high association between terms. However, several codes are repeated across the drought management strategies, meaning that these relationships are still a bit tenuous and muddied. Although the overlapping codes in the centre of Figure 103 have significant correlation to each Reduce code, that they had correlation to all is perhaps disqualifying in terms of concluding that they limit resultant strategies. The question at hand is not only whether certain framings influence specific solutions, but whether this creates a limited range of possible options, as charged within the literature (McEvoy, 2014; Mehta, 2003; Omari Motsumi et al., 2023). Thus, it seems that the overlapping codes in Figure 103 do not necessarily limit resultant drought strategies. Conclusions may be better drawn from the codes unique to each Reduce strategy, even though they may have weaker correlation coefficients per code than some of the shared codes. As such, it may be that a Cultural Impetus limits solutions to Reduce- Exposure strategies; Social Impacts, Economic Impacts, and Increased Water Demand may create an over-reliance on Reduce- Vulnerability Strategies; and Quantification, Political impetus, Event impetus, Hydrological definitions, and Regional understandings of drought may overly lend to Reduce- Hazard solutions.

What is clearer from the results are which means of drought issue framing are *not* significantly tied to mitigation strategies within city plans. Across each Reduce- code, Knowledge inputs and Temporal scales were not represented at all. The Drivers of Climate Change, Economic Development, Population Growth, and Resource Degradation did not feature as significant; nor Agricultural, Ecological, Meteorological, or Socioeconomic definitions of drought; nor Environmental and Social Impacts; and finally, nor did International, Local, and National Spatial scales. As a whole, these results indicate that the Conception (Huff & Mehta, 2019), Impetus (Buurman et al., 2017), and Understanding (Müller & Kruse, 2021) categories of drought framing have a stronger bearing on resultant drought mitigation strategies than the other forms of Sense-making and Naming the Problem investigated in this analysis, with a few exceptions across the other categories. Future analyses might narrow in on these framing factors across a more granular set of drought mitigation strategies to further query the connection between issue framing and drought solutions.

5.4 Results for RQ4: Does the framing of drought impact the distribution of drought management strategies among users?

Figure 9 shows that Water Provider actions far outpace the responsibility of other users to respond to drought conditions. The prevalence of coded text for each user is reproduced in Table 9 to more clearly show the attributed actions across users. The coded text included both the benefits and burdens of drought solutions; but because these codes are concerned with action or responsibility across users, rather than the acknowledgement of impacts, the majority of text was related to having to take some action (i.e., undertake a burden) in response to drought conditions. Further, text was only coded when user groups were clear; for example, actions targeting "all users" could not be coded if the plan did not define its users in the first place, as some water providers do not have all types of users under study or may not differentiate them in the same way as conceived in the coding scheme. Further, evidenced in part by its low prevalence, most water providers did not consider the Environment to be a discreet user. The Environment, Industrial, and Agricultural users are all targeted relatively infrequently, with more actions targeted toward Commercial, Residential, and Institutional users, and the most to the Water Provider itself. The major theme across most user categories was reducing water use, although the Environment as a user also entailed the theme of maintaining environmental flows, and the Water Provider as a user entailed activities ranging from system operational efficiency to procuring further water supplies.

Table 9. Sum totals of the prevalence of users implicated within drought management solutions across all plans.

Agricultural	Commercial	Environment	Industrial	Institutional etc.	Residential	Water Provider
38	102	21	37	69	93	306

The Pearson correlation coefficient was again used to determine the relationship between Sense-making and Naming the Problem codes and the Users codes (Figure 104). The only similarity indices of significance (>0.8) were with the Water Provider code, and between Residents and Impetus- Cultural. Within Impetus- Cultural, much text was about enabling behaviour change toward wise water use among users, particularly in contexts where the water provider deemed that residents did not grasp the value of water (such as in Johannesburg). Thus, it follows that there would be a correlation between a Cultural impetus for drought planning and Residential users. Among the significant similarities for the Water Provider, the most significant at 0.899 is between a Techno-managerial conception of drought and action by the Water Provider. The position of a Water Provider as an institutional force with legal jurisdiction to obtain more water supplies, legal or contractual obligation to provide safely managed water, control and improve water distribution infrastructure, and broker deals or relationships with other entities, provides a logical explanation for most of the high similarity values displayed in Figure 104, as many of the other user categories cannot engage in these activities. With that in mind, Scientification is an interesting omission from the high similarity values; this could be because a key consideration of the Scientification code is a call for further study or more data rather than resulting in a more direct drought mitigation activity.

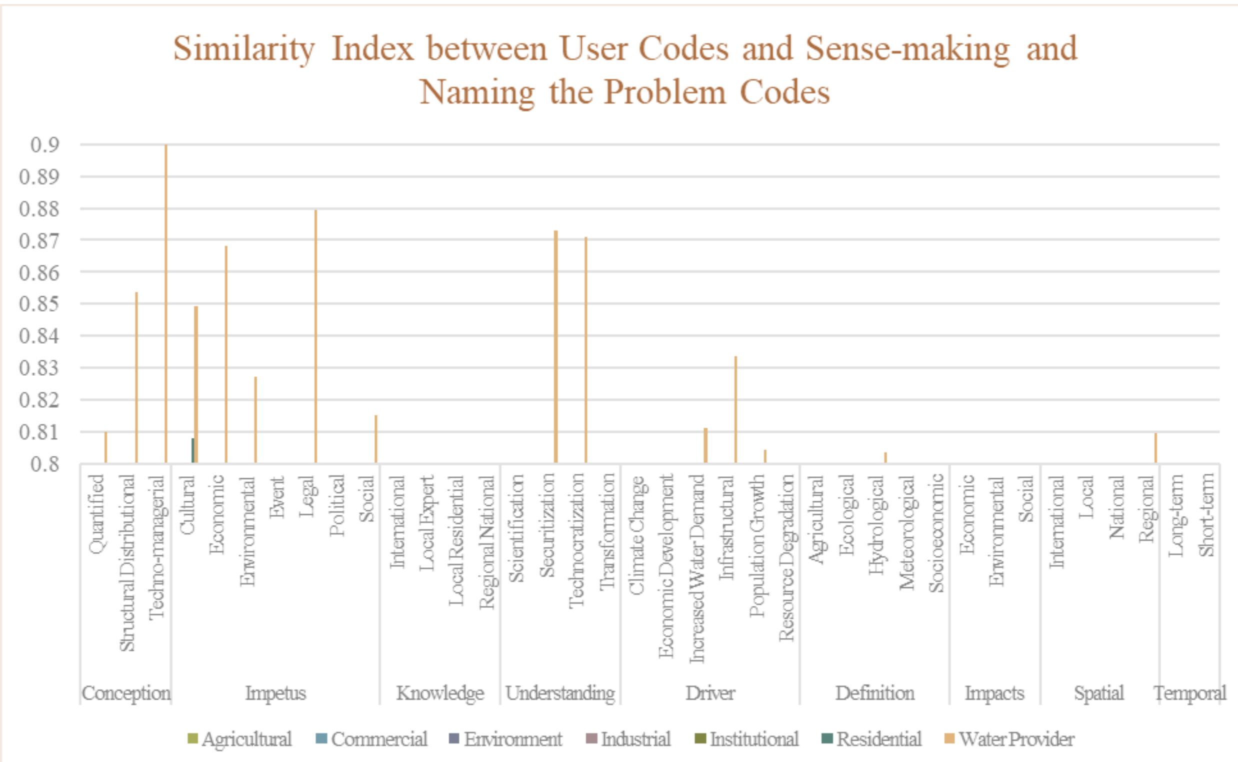

Figure 104. The Pearson correlation coefficients greater than 0.8 for Sense-making and Naming the Problem codes with similarity to the Users codes.

Similar to the conclusions drawn from RQ3, these results show that codes within the categories of Conception, Impetus, and Understanding have a greater correlation to drought mitigation strategies among users than other forms of Sense-making and Naming the Problem. However, this is only true for Water Providers. The other user groups are unrepresented (with one exception), implying either that the coding scheme employed in this analysis could not capture the connection between drought issue framing and the users implicated within that framing, that these plans do not define their users enough to capture this connection, or that such a connection may not exist.

6 Discussion

This section connects the results of each research question back to the three narratives about urban drought that were found during the literature review. Implications are taken from the results and expanded upon with reference to the content from city plans and from broader conceptions about drought mitigation. Care is taken to contrast the general trends within this cohort of cities with specifics from individual cities so as not to obscure the unique drought planning context of each city.

6.1 Alignment with Global Drought Models

The questions at hand in determining whether this cohort of cities aligns with global urban drought models relate to first acknowledging whether cities reference these studies, whether their drought plans align with the predictions within them, and addressing questions of scale about the usefulness of global drought models.

A first method to understand whether cities align with global urban drought models is to take stock of their references to such studies or international bodies of work, as exemplified by the Knowledge- International code, which had an overall prevalence of just 15 references across all city plans. These references were principally to the Intergovernmental Panel on Climate Change (IPCC) and their annual assessments about climate impacts, in which drought features prominently alongside references to predicted changes in global precipitation patterns. After the IPCC are references by Amman and Singapore to the World Resources Institution (WRI) ranking of the world's most water-stressed countries, where both are featured (Kuzma et al., 2023). No other international study or knowledge source is mentioned more than once. This demonstrates the influence of the IPCC and WRI water-related reports on the cities in this cohort, while implying that these cities may not otherwise be very tuned into the academic literature which predicts their demise.

However, the frequency of the Driver- Climate Change code is very notable. The next most frequent code within Naming the Problem, Impacts- Environmental, appears less than half the time as Climate Change (Figure 8). Studies about global urban drought risk tend to imply that cities do not realize the extent to which climate change threatens their water supplies; however, every city in this study recognizes climate change as a driver of their drought issues. Most of these cities identify Climate Change as the *number one* driver of future drought problems, with few other naming the problem codes coming close. The requirement for inclusion in this study of membership within C40 Cities or RCN may have produced a particularly climate-knowledgeable sample of cities, so more investigation into this is warranted; but drought itself is a lesser focus of these networks, implying some validity to this finding. Further, several global drought studies (McDonald et al., 2014; Zhang et al., 2019) implicate large cities specifically, which are more likely to join networks such as C40 or RCN and have influence within them (Kamiński, 2023; Lee & van de Meene, 2012). Interestingly, however, Driver- Climate Change does not seem to correlate with any of the Reduce codes (Figure 102), implying that recognition of climate drivers does not correspond to any particular drought action. Perhaps it is that the threat of climate helps to spur planning generally, while specific mitigation measures arise due to other reasons.

As far as the specific studies referenced in the literature review Section 2.3, many do not list the cities they analyse, except to provide them in a static map form. Thus, only the studies that specifically list cities that overlap with the present analysis are discussed further here. Los Angeles is implicated as having severe water stress now and into the future in several of the global drought risk analyses (He et al., 2021; McDonald et al., 2014; Stolte et al., 2023), but its own DP does not anticipate water shortages under any of its modelled scenarios ("LA DP 2020"). Even still, the City is pursuing additional water supply augmentation options including to bolster the amount of supply from local sources, and it is one of the signatory cities of C40's Water Safe Cities programme (C40 Cities, 2022a). Bengaluru is under threat of water scarcity according to both He et al. (2021) and McDonald et al. (2014). Bengaluru acknowledges this threat; however, the city also has a stronger conception of water scarcity being due to Structural/Distributional factors, including its high rates of water loss, rather than per the net water availability metrics used in these two studies. Chennai is also named as having high water stress (the ratio of water use to availability) by McDonald et al. (2014). The city's own narrative aligns with this, as it names the depletion of wetlands (crucial for both surface water storage and aquifer recharge) as driving its water availability issues alongside increased demands. This is not quite as simple as insufficient supply per capita, though, but rather the interplay between population growth and economic development encroaching on water supplies in a way that compounds depletion. The final city named in these studies was London, where McDonald et al. (2014) recognize it to be water-stressed as does its own DP ("Thames Water DP 2022"), but Guerreiro et al. (2018) predict only moderate drought risk in the worst-case scenarios for London. In sum, the accuracy of these global predictions of water scarcity varies per city, and even when accuracy overlaps, the cities tend to have a more in-depth understanding of the additional factors to simple supply/demand that are causing concern about future water availability.

In its Water Safe Cities initiative, C40 identifies the risk of its cities to hydrological and agricultural drought, determining Singapore to be at medium risk; Johannesburg, London, Sydney, Cape Town, Melbourne, and Durban to be at medium-high risk; and Los Angeles to be at high risk (C40 Cities, 2022b). This is interesting given the low prevalence of hydrological drought as a significant drought definition within these plans, and the even lower prevalence of agricultural drought metrics. Only London is concerned with Hydrological drought metrics to the extent that it overtakes other Naming the Problem codes (Figure 62). Sydney mentions Hydrological drought six times and Agricultural just once (Figure 14), and Los Angeles seven and one, respectively (Figure 71). Melbourne, Singapore, Cape Town, Durban, and Johannesburg do not use either hydrological or agricultural drought definitions (Figures 11, 47, 50, 53, and 56). Further, the only three drought adaptation measures that C40 uses to calculate the financial impacts of drought are increasing water storage capacity, reusing wastewater, and increasing desalination, chosen based on the availability of a global unit cost estimate (C40 Cities, 2022b). Water conservation and efficiency are not featured although this study finds them to be more prevalent strategies (Figure 9). None of the cities in this cohort discuss their drought mitigation options in the terms of global unit prices; more often, when cost is discussed at all, it is in terms of choosing the most cost-effective drought options, which are largely recognized to be water conservation (Reduce-Exposure) mechanisms. It is interesting that the metrics used by C40 in describing global urban drought risk are so disconnected from their member cities and shows that this disconnect can happen among TMNs as well as scholarly sources. RCN does not have a similar accounting of water issues for its participants; however, three cities within this study—Addis Ababa, Amman, and Johannesburg— participate in its City Water Resilience Approach, documents from which were data sources coded in this analysis.

Cities within this analysis also noted the uncertainty that accompanies predictive modelling approaches for water scarcity under climate change. Bengaluru notes the discrepancy between scales of this information, saying, "the climate change hazards that are most likely to put at risk [the] water and sanitation sector in Bangalore consist of possible changes in precipitation: in total annual rainfall, distribution of twin peaks, and increase in intensity and frequency of extreme events (Revi, 2008,). There is limited information available at Bangalore on these changes as robust down-scaled regional models are not yet available" ("Bangalore Plan for Water and Sanitation Infrastructure 2014", p. 41). In other words, national and global models indicate that Bengaluru will have issues with water availability due to changes in precipitation, but Bengaluru cannot downscale this to determine further specifics. This is a problem even in cities which may be considered more sophisticated; Berkeley and Oakland, noted climate progressives with a large research university, note the uncertainty that comes along with predictive models: "It is important to note that the modeling of climate change is still an imperfect science, especially at the level of granularity required to study a specific watershed. There is no standard model that is used to quantify the effects of climate change on watershed hydrology" ("East Bay DP 2020", p. 9). Finally, Sydney clearly describes the ways in which quantifying water supply reliability is an imperfect science, stating, "The 2017 Metropolitan Water Plan proposed a set of drought measures based on planning or providing infrastructure that would be triggered at specific dam levels. However, the 2017-2020 drought was more intense than anticipated in the plan. We now know that had the drought conditions persisted for another two years, it is unlikely we could have built the required infrastructure in time to avoid severe restrictions or even running out of water" ("Sydney Water Strategy 2022", p. 43). These examples reiterate the problem of scale; even if global water scarcity models were accurate worldwide, there are issues in trying to translate these into appropriate local understanding and action. Further, if the reality is worse than what is predicted, drought management and mitigation problems will persist. This suggests a limited utility of global drought models for water management in practice, except perhaps to raise the alarm and inspire further planning—but as seen from the Climate Change code, these cities do seem adequately alarmed.

6.2 Alignment with Urban-Rural Drought Divides

The results of this study indicate that fears over cities siphoning away rural water supplies are perhaps overblown, or that such decisions are the jurisdiction of authorities other than cities themselves. Out of the 30 cities, only El Paso was considering buying agricultural water rights or subsidizing agricultural water users to the city's benefit ("El Paso DP 2020"). El Paso's earlier Water Strategy considered an agricultural transfer as well, but ultimately pursued a more cost-effective option: "The three alternatives to the no action approach for supply being evaluated as part of this study are: increasing the reclamation of impaired waters by expanding [aquifer storage recovery] ASR or importing water from either Diablo Farms or Southern Hudspeth County," with the ultimate recommendation of the plan being ASR ("El Paso Water Strategy 2021", p. 43). The Reduce- Exposure code being most prevalent is relevant here as well, as aggressive pursuit of system efficiency and water conservation reduces the need to augment water supplies, thus also decreasing threat to rural water supplies. These results further provide a counterexample to studies which show an overreliance on water supply source augmentation by water providers (Buurman et al., 2017; Grecksch & Landström, 2021; Hornberger et al., 2015)—though rainwater harvesting and water reuse are within Reduce- Exposure, and could be counted as new water supply sources, depending on one's perspective. But rainwater harvesting and water reuse are augmentation sources which have no bearing on rural supplies. This aligns with Hooper's (2015) argument that processes of urbanisation can re-open closed water basins because they necessitate changes in water allocation and change patterns of consumptive water use, wherein urban supplies may be used more efficiently per capita and be non-consumptive, returning to the environment in the form of wastewater, or recycled back into the urban water cycle as reuse. These particular dynamics will depend upon the city and water basin in question, but the general pattern seen within this study lends support to this idea.

Additionally, as stated in the results, 15 cities note specific concern about agricultural impacts, and seven want to actively support agricultural users during drought, including to embrace urban agriculture inside city boundaries. Support includes providing water supplies to agricultural users that might otherwise be rain-fed or privately supplied, subsidising the sector, or through integration of the sector into urban boundaries through urban agriculture programmes. The support that urban areas may provide to the agricultural sector is largely absent from the water reallocation literature, warranting further attention and due credit. Encouragement of urban agriculture adds further nuance to the proposed rural-urban water divide that proliferates in the reallocation literature, supporting calls from Hooper (2015) to acknowledge that the lines between 'agriculture' and the 'urban' are increasingly blurred. Treating the rural-urban divide as set and impermeable creates a perception of water competition, where in reality there may be much more of a supportive environment between urban and rural water users—and in fact, that some urban water customers may also be agriculturalists.

A final point of nuance, however, are the nine cities which have agreements for Provider-Provider transfers. That these are agreements between water providers does not mean that they are free of implications for agricultural users; for example, one of Los Angeles' agreements is with the Antelope Valley–East Kern Water Agency (AVEK), which also supplies ranchers and agricultural users ("LA DP 2020"). If an emergency transfer occurs from AVEK to Los Angeles, is it because AVEK curtails use for its agricultural users, or because drought surcharges mean that only other institutional users like the city can afford emergency supplies? The answer to this specific instance is beyond the scope of this analysis—and indeed, not recorded in academic literature—but posing the question sheds light on the ways in which agricultural water transfers could have more to do with the business decisions of a rural water agency or irrigation district, rather than the discreet demands or institutional power of a city. This is an important distinction, given the lack of evidence within this study about cities considering agricultural water transfers as responses to drought. While cities benefit from agricultural water transfers regardless of the initiating factors, properly identifying the initiating factors is crucial for properly assigning blame—if blame is to be assigned—and thus more accurately assess and prevent the problem from occurring. If cities are not the initiands of agricultural transfers, then problem investigation and related solutions are to be found at other levels of government. This study can only conclude that by far, these cities do not initiate agricultural water transfers in their long-term climate adaptation plans, nor their drought plans; but it could be that such transfers are "unplanned" drought mitigation mechanisms, warranting further investigation. Cape Town's instance of the Transfer- Ag-Urban code could be instructive in this, as the city did benefit from an agricultural water transfer during its recent drought yet does not include further ag-urban transfers for its future water strategies ("Cape Town Water Strategy 2019").

6.3 Alignment with Water Scarcity as Socially Constructed

Within this narrative about urban drought, there are two implications: first that the framing of water scarcity limits the solutions considered, and second that scarcity arises due to the misallocation of water across society. RQ3 answers the first through similarity indices, and RQ4 answers the second through identifying the distribution of drought responsibility as written by the water provider.

First, the applicability of formalised definitions appears to be low. The results of this study indicate few references to the various definitions of drought solidified within the literature (Wilhite & Glantz, 1985). Rather than employ the definitions of drought in their entirety, cities more often use drought indicators which may correspond to the more formal drought definitions. This shows alignment with the World Meteorological Organization's *Handbook of Drought Indicators and Indices,* which provides a suite of indicators to choose from, rather than being prescriptive about definitions (Pischke & Stefanski, 2016). This finding calls into question the relevance of debates in the literature surrounding drought definitions, echoing claims from Elie (2024) and Savelli et al. (2022) that further specifying drought definitions might be needlessly pedantic. For example, Crausbay et al. (2020)'s argument that more precise definitions of ecological drought would lead to anticipatory drought management is questionable, given the low rates of concern for the existing ecological drought definition among cities. Notable among these are its low prevalence among regional water providers like those in the UK, which have a broader jurisdiction over the whole catchment and where ecological indicators might be more useful. Of course, scientific specificity is important in its own right; but it is hard to see from these results whether it would have bearing on drought management in practice by water providers, as in addition to low prevalence, Hydrological drought is the only definition which correlates to action (to the Reduce- Hazards code).

The utility of formalised drought definitions is also somewhat questionable because several cities created their own definitions to contend with. For example, Auckland's water provider states, "Watercare defines drought as a shortage of rainfall that has caused or threatens to cause depletion in water storage lakes or other raw water sources to levels that may lead to an imbalance between supply and demand. An extended meteorological drought that affects urban water supply is termed 'hydrological drought'" ("Auckland DP 2023", p. 17). Similarly, although Calgary includes all of the formalised drought definitions within its Drought Plan in an infographic, it ends up with its own definition: "drought is defined as the condition when the water required for municipal supply, irrigation, and minimum environmental flows diminishes below City of Calgary drought triggers and supporting indicators" ("Calgary DP 2023", p. 6).

In terms of problem definition as opposed to formal drought definitions, as discussed in the results for RQ3, while several codes have high correlation to the three categories of drought mitigation solutions under review, many of these correspond to multiple solutions. Thus, it can be concluded that while these components of issue framing may *influence* solutions, they do not appear to *limit* them. This is notable for the Techno-managerial and Technocratization codes, as overly managerial solutions were specifically charged with limiting available solutions within the literature (Finley & Basu, 2020; Linton & Saadé, 2024; Román, 2010). Further, many codes did not have significant correlation at all, indicating little influence on the resultant solution. What are left are the codes which had significant correlation unique to each of the three Reduce- codes.

The clearest thread is between a Cultural Impetus for planning and the Reduce- Exposure code. This could connect to the themes within the Impetus- Cultural coded text, which tend to relate to changing water user behaviour, building on the legacy of the water provider's success, and getting customers to recognise the value of water. All of these refer to the need to 'use water wisely.' Singapore embodies this first theme by describing its World Water Day activities which help to build community awareness about water-conserving actions ("Singapore PUB Sustainability Report 2023"). Austin demonstrates the idea of legacy-building, saying "The City of Austin (the City) maintains a decades-long commitment to ensuring a sustainable water supply through demand management measures. The latest update to Austin's Drought Contingency Plan (the Plan) builds upon this legacy" ("Austin DP 2024", p. 3). Johannesburg exemplifies the final theme, saying, “Therefore, the City and its residents need be aware of the fact that water is a scarce resource and make efforts to conserve it” (“Johannesburg CAP 2021”, p. 106). These examples help explain the high correlation between the idea of drought as a cultural issue and why it points to water conservation as the needed solution; ultimately, culture implies the use of water, rather than its supply source or its allocation as represented more in the Reduce- Hazard and Reduce-Vulnerability categories.

Reduce- Hazard and Reduce- Vulnerability are more fraught, however, with five and three unique but significant framing inputs, respectively (Figure 103). Justifying these connections would be speculative. It follows logically that Quantification, Political Impetus, Event Impetus, Hydrological Drought, and a Regional spatial reach all imply a need for the water provider to gain more water supplies, and perhaps especially to solidify the allocation of these supplies amid competition from other agencies, as in Reduce- Hazard. It follows logically that Economic and Social Impetus and Increased Water Demand might necessitate water metering and pricing, as in Reduce- Vulnerability. However, the tools of this analysis are insufficient to separate these components of issue framing to verify these potential connections further. It also cannot determine whether these factors are needed together to result in the solution category, or if they do so individually with equal merit. Even without further analysis, however, these multiple inputs complicate the idea that drought definition determines solutions. It may be that framing can limit solutions *per city*¸ rather than as a general rule.

These correlations—and lack thereof—speak to the cohort of cities as a whole; but as shown in the results for RQ1, some cities have quite a clear relationship between codes, and others do not. The two framing code categories—Sense-making and Naming the Problem—both had almost half of the codes (1124 and 1090 respectively) as Naming Solutions (1886). Many cities had low prevalence across the framing codes but high amounts of solutions codes. This reinforces the operational nature of drought plans, suggesting that water providers may see the problem of drought as self-evident, with little need for preamble or justification (besides the driver of Climate Change, of course), and complicating issue framing in specific cities. Melbourne’s results require little analysis to see that the environment is a strong theme, from issue framing to solution implementation. In Melbourne, drought is an environmental issue which requires environmental solutions. Pune, however, with low overall coding, and numerous of the coding categories represented, is more difficult to trace. Its most numerous codes have just three or four occurrences each. It is safe to say that according to Pune, drought is perhaps a lesser concern overall in its city plans; and when it is addressed, there are various dimensions to the problem of drought, which require various solutions. To simplify this into a more direct logical order could also have the effect of limiting the solutions that the city explores and implements. The results for Cape Town, with Climate Change being the predominant problem named (Figure 50), aligns with studies which accuse the city of a myopic conception of drought which lend to solutions concentrated in bolstering water supplies, such that its own managerial contributions to the crisis are under-acknowledged and may not be prevented from occurring again the future (Muller, 2018; Savelli et al., 2023; Simpson et al., 2020). However, this points to the need to supplement framing analysis with critical inquiries into institutional power and responsibility during drought, given that the city's plans do not acknowledge any water management shortcomings which may have contributed to its water crisis.

In tracing the correlation of the codes across the cohort of cities and through inductive analysis of each city's drought framing profile, there emerges a difference. While it is that generally, framing like Impetus- Cultural can lead to Reduce- Exposure results, this may be untrue in specific instances. Even in its pursuit of rainfall-independent supplies, Sydney shows much awareness of this distinction as it discusses the limits to the framing of 'rainfall independent supplies': "However, this strategy also recognises that we cannot completely 'drought proof' or 'flood proof' the system through new investment and infrastructure—that is not technically feasible and would be prohibitively expensive. Rather, we have to make prudent decisions to mitigate risks, taking into account the likelihood, potential costs and impacts of these risks, our ability to mitigate them and the costs associated with mitigation" ("Sydney Water Strategy 2022", p. 46). This shows that even with strong branding of the problem, Sydney recognises that it cannot get carried away with solutions that solely relate to rainfall independence, as this may be too narrow-minded and less feasible than other options. The takeaway is thus that water providers should be aware of their framings and related solutions, so that they can better evaluate efficacy and ensure holistic solutions result.

This study attempts to engage with the claim that water scarcity arises due to misallocation of water resources in society by examining the distribution of responsibility for drought mitigation, as expressed within city plans. One might assume that residents, or specific classes of people, might be most targeted by drought mitigation strategies, given this uneven distribution of water. However, the results for RQ4 suggest little correlation between the framing of drought issues and the users implicated within mitigation strategies, aside from the Water Provider itself. The next most-discussed user category was Commercial, followed closely by Residential, then Industrial, Agricultural, Institutional, and finally, the Environment (Table 9). Notably, residents of informal settlements within South Africa often do not face any sort of water restrictions during drought because maintaining service to the standpipes that supply drinking water is a constitutional mandate in the country ("Durban Water Policy 2021"). In this way, the burden that they bear during drought is not more significant than under the water scarcity they are subject to under "normal" conditions; but the same may not be true for other low-income South Africans, nor true for residents of informal settlements in other countries. A Cultural Impetus corresponds to targeting Residential water users, for reasons that may be similar to those explained for its prevalence with the Reduce- Exposure category generally: water conservation initiatives may favour a behavioural change approach. Otherwise, the Water Provider is responsible for action as correlates with numerous sense-making and naming the problem codes. The highest of these are Techno-managerial and Legal impetus, but like the multiple inputs which correlate to Reduce- Hazard and Reduce- Vulnerability, this analysis is limited in explaining these factors further, except through speculation. Generally, the Water Provider taking responsibility for drought mitigation actions within a centralised system and as expressed by formal government and agency documents makes sense, as these plans often function as operational guidelines for the water provider more than other stakeholders. In terms of studies which contend that drought problem definition is also a process through which stakeholders compete for priority (Kaika, 2003; Müller & Kruse, 2021; Paneque Salgado & Vargas Molina, 2015), it would appear that the primary stakeholder addressed through drought planning is the water provider itself, over other sectors. The categories of framing which had the most bearing on both resultant strategies and users were Conception (Huff & Mehta, 2019), Impetus (Buurman et al., 2017), and Understanding (Müller & Kruse, 2021), suggesting that future studies about drought issue framing can prioritise these means of framing.

As noted, the results for RQ4 come about in part because these plans often did not define their user base, nor define which customer category is the target of drought mitigation actions, even when the action itself implies a target audience. This is an important omission across plans because of two factors: one is clarity, or lack thereof, for users during drought, and the second is related to accounting purposes and mitigation strategy efficacy. Perhaps the target users become more defined as messaging campaigns are rolled out during drought, but as written within most plans, it may be unclear which users need to take which actions, or which programmes they can benefit from. For example, are commercial properties subject to day-of-week landscape watering restrictions? Can restaurants or hotels benefit from water fixture rebates for taps or showerheads? In most plans studied, these are unanswered questions. On the accounting side, clearly defining each customer category and calculating their proportion of water use can create much more targeted drought mitigation strategies, as different techniques work better for different users, and further reductions in water consumption can be achieved with proper attribution. Expensive water tariffs often do not work on high-income individuals nor the commercial/industrial sectors (Hensher et al., 2006; Savelli et al., 2023). Attempting to reduce household water use can achieve only marginal gains in cities which have a large hospitality sector, as tourists need more targeted interventions (Deyà Tortella & Tirado, 2011; Gabarda-Mallorquí & Ribas Palom, 2016). Addis Ababa, for example, has a strategy to target high water users ("Addis Ababa RS 2020"), and determining water use per customer category could aid in further targeting this idea. There are limitations to achieving this breakout of customers within cities which lack water meters, or which have high rates of water loss; but it is a worthy goal that would support more targeted drought mitigation strategies.

7 Conclusion

Three prominent narratives exist with urban drought literature: that cities will be caught off-guard by a silently unfolding urban water crisis; that cities will encroach upon rural water supplies; and that water scarcity is constructed by the powers that be to obscure water mismanagement and misallocation. Scholars contend that the definition of urban drought problems lends to their solutions, through a process of framing wherein inputs and conceptions may only select aspects of the problem to solve, while other solutions are discarded (Cravens et al., 2021; van Hulst & Yanow, 2016). Drought plans are signals of future action which come about as a result of the framing process (American Planning Association, 2019; Del Moral Ituarte & Giansante, 2000; Hopkins & Knaap, 2018). This study investigated the framing of urban drought risk through qualitative content analysis to gain insight from cities themselves about these narratives, as many of these claims arise from studies which do not use primary data from cities at scale. A coding scheme for analysis was developed based on existing literature and from prominent themes within city plans related to drought. Thirty cities were analysed across ten countries to address four research questions:

- RQ1. How are urban drought risks framed and justified by cities?
- RQ2. Do issues of urban-rural water allocation emerge in urban planning processes?
- RQ3. Does the framing of drought impact chosen drought management strategies?
- RQ4. Does the framing of drought impact the distribution of drought management strategies among users?

This conclusion proceeds by recapping the main points within the three prominent narratives in urban drought literature, with response from the results of this study which reiterate the answers to each research question. Ultimately, the findings provide a counter-narrative for many of the points raised across these urban drought narratives, demonstrating the importance of engaging with primary data from cities when trying to situate them within trends.

7.1 Responding to Global Urban Water Scarcity Models Using City Data

There are numerous alarming reports of a looming urban water crisis, predicting water issues in up to one in four large cities in the future (He et al., 2021; Hoekstra et al., 2018; McDonald et al., 2011). However, critics argue that these models are often based on incomplete data and may not reflect local realities (Bruns & Frick-Trzebitzky, 2014; J. W. Hall & Leng, 2019; Puy & Lankford, 2024). Specifically, there is a separation between drought forecasting and actual water management practices, with some cities cited as both drought hotspots and examples of effective drought management. Additionally, some argue that framing water scarcity as an inevitable global crisis depoliticizes the issue, leading to a narrow focus on technical solutions rather than addressing the broader social and political aspects of water allocation (Finley & Basu, 2020; Linton & Saadé, 2024; Román, 2010).

The results of this study indicate that cities are acutely aware of climate impacts on drought in their bounds. Every city under study recognized climate as a driving factor for their drought-related planning, with most cities recognizing it as the number one driver. This indicates that global warnings about water scarcity due to climate change have worked; however, the source of data for most cities is the IPCC rather than other academic studies. Additionally, recognition of climate change did not correlate to any of the solution codes, suggesting that it does not inspire specific actions. Further, it was found that cities conceive of their drought preparedness differently than expressed by global studies. Four studies in the literature implicate Los Angeles, while Los Angeles' drought-related plans claim that local hydraulic simulations do not predict future water shortages. Among the other cities in this analysis named by these dire predictive studies, it becomes clear that they have more holistic conceptions of drought and water scarcity than presented within global models. The global models tend to consider a measure of water supply availability versus water use; but on the local level, cities like Bengaluru recognise the social and management factors which also contribute to water scarcity issues. Several cities under study noted the discrepancy between global models which predict drought issues in their regions, and the unavailability of local models to determine specific impacts and timing. Furthermore, they note the danger in relying on models which may be inaccurate, as inaccurately assessing the threat of drought can lead to planning which develops insufficient preparedness. For cities then, the concern is less that global models depoliticise the issue of water allocation, but more that they are insufficient at the local level to be of much use, except to sound the alarm.

7.2 Urban-Rural Water Reallocation: More Mutually Supportive than Portrayed

Urbanization requires large amounts of water, often sourced from distant regions (Cantor, 2021; Richter et al., 2013; Scott & Pablos, 2011). This 'hydraulic reach' can threaten the water supplies of rural areas. The agricultural impacts of drought receive a lot of attention, in no small part due to the acute impacts on crops and soil health. Urban areas could exacerbate this vulnerability by reallocating water from agriculture to urban needs during emergencies—and indeed, many studies have been done to demonstrate the urban threat to rural water supplies (Celio et al., 2010; Garrick et al., 2019; Molle & Berkoff, 2006).

The results of this study indicate that fears over urban-rural water transfers may be overstated, as only one out of 30 cities is considering an agricultural transfer within its network of plans. It is more common for the cities studied to be actively concerned about the agricultural impacts of drought, such that they have programmes in place to support agriculture during emergencies, either through direct provision of water or through financial and programmatic aid. Several cities also aimed to initiate programmes to support urban agriculture, further blurring the lines of the rural-urban divide and demonstrating one way that this portrayal contributes to unneeded perceptions of competition between water users. Urban agriculture is generally an under-explored dynamic in the reallocation literature, which may lend to depicting cities as rural water-grabbers more than is warranted. However, the dynamics which defend cities in rural-urban water issues are nuanced by the high proliferation of water transfers planned between water providers, wherein some rural water providers may serve agricultural users as well, and it is not clear how the benefits and burdens are distributed under such arrangements. Nonetheless, it then becomes the purview of the rural water provider in making this water allocation decision, rather than a process instigated by the urban water provider.

7.3 Does Drought Definition Determine Solutions?

Critical scholars argue that scarcity is a socially constructed concept used to justify resource accumulation by governments and the private sector (Kaika, 2003; Kallis, 2010; Mehta et al., 2019). According to this strain of thought, water scarcity and drought are not solely natural phenomena but are deeply shaped by human actions, and presenting them as natural can obscure these anthropogenic drivers (Aguilera-Klink et al., 2000; Mehta, 2003; Van Loon & Van Lanen, 2013). Because scarcity is constructed, how drought is defined influences how it is managed, and actors ranging from the local government to industries can use a process of problem definition to advocate for their favoured solutions (M. Muller, 2018; W. Müller, 2020; Sonnett et al., 2006). Doing so can lead to drought mitigation measures with limited beneficiaries; and in which the impacts can be avoided by those with the willingness and ability to pay, whilst borne by the most vulnerable in society (Huff & Mehta, 2019; Santha & Sasidevan, 2018).

Responses to these themes within this analysis are quite fraught. There was significant correlation between the framing codes and solution codes; however, several of the codes with high correlations also appeared across each of the three solution codes, indicating that they may influence solutions but do not limit them. With those codes removed, it appears that a cultural impetus for drought planning corresponds to strategies which reduce exposure to drought, potentially due to the behaviour change strategies employed to reduce water use within this category. Three codes uniquely correlated to reducing drought vulnerability, and five uniquely corresponded to reducing drought hazards. Thus, these results indicate that the only framing that matches a singular solution is that a cultural impetus—that is, striving to be more water conscious—lends to water conservation and efficiency responses to drought. Other strategies have multiple inputs, complicating the idea that definition determines solutions. That problem definition limits solutions is further confounded by each city's drought framing profile, some of which have clear links between sense-making, naming the problem, and naming solutions, and others which simply do not have these clear links. Whether drought issue framing results in certain stakeholders being targeted over others has similar qualifications. There was a specific connection between cultural impetuses and residential water users, likely for similar reasons to water conservation and efficiency. The only other user with significance from the similarity indices, however, was the water provider itself—and it had multiple inputs as well. These results did reveal that many categories of the coding scheme did not have significant bearing on resultant solutions or user classes, and that the utility of drought definitions as proposed in scholarship is low for water providers.

Ultimately, it is not that the three urban drought narratives are wrong; it is that they obfuscate the context in which cities are operating when they do not engage with the data and drought planning procedures of cities. It is not right to claim a pending water crisis in a city which is putting mitigation procedures in place; it is not right to claim cities threaten agriculture when they are concerned with protecting it; and it is not right to assume cities have myopic understandings and solutions to drought. Whilst giving cities too much credit can be problematic, as they are centralised institutions which can make poor and unjust management decisions, one should also recognise their sophistication in urban drought definition and problem-solving, particularly since generalised data can be inaccurate and unhelpful at the city-scale. The cities in this study understand the threat of drought due to climate change—properly responding to it requires local capacity and specificity. Overall, this study reveals the wide gap between research and practice in regard to drought framing and management, and implores researchers and organisations alike to engage with primary data from cities. Centring the context of a city's drought operations will make critiques and calls for improved management all the stronger.

8 References

"Addis Ababa CAP 2021." City of Addis Ababa. (2021). *Addis Ababa Climate Change Action Plan (2021-2025).* Addis Ababa Environmental Protection and Green Development Commission in collaboration with C40 Cities Climate Leadership Group. https://drive.google.com/file/d/1IBHkbCOH680egHCxgPf2o9M_fJdaNfMi/view.

"Addis Ababa RS 2020." City of Addis Ababa. (2020). *Addis Ababa Resilience Strategy.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Addis-Ababa-Resilience-Strategy-English.pdf.

"Addis Ababa Water Resilience Profile 2021." ARUP. (2021). *City Water Resilience Assessment: Addis Ababa Water Resilience Profile.* https://www.arup.com/globalassets/downloads/insights/c/city-water-resilience-approach/profile/addis-ababa-water-resilience-profile.pdf.

"Amman CAP 2019." Greater Amman Municipality. (2019). *The Amman Climate Plan: A Vision for 2050 Amman.* https://www.amman.jo/site_doc/climate.pdf.

"Amman Green City Action Plan 2021." Greater Amman Municipality. (2021). *Amman Green City Action Plan.* https://www.amman.jo/site_doc/AmmanGreen2021.pdf.

"Amman RS 2017." Greater Amman Municipality. (2017). *Amman Resilience Strategy.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Amman-Resilience-Strategy-English.pdf.

"Amman Water Resilience Report 2018." ARUP. (2018). *City Characterisation Report: Amman.* https://www.arup.com/globalassets/downloads/insights/c/city-water-resilience-approach/characterisation-report/ccr-amman.pdf.

"Atlanta CAP 2015." City of Atlanta. (2015). *City of Atlanta Climate Action Plan.* https://atlantaclimateactionplan.wordpress.com/wp-content/uploads/2016/02/atlanta-climate-action-plan-07-23-2015.pdf.

"Atlanta DP 2022." Metropolitan North Georgia Water Planning District. (2022). *Local Drought Planning Guide for Metropolitan Atlanta.* https://northgeorgiawater.org/wp-content/uploads/2015/05/Local_Drought_Planning_Guide_Metro_Atlanta_2022_FINAL.pdf.

"Atlanta RS 2017." City of Atlanta. (2017). *Resilient Atlanta: Actions to Build an Equitable Future.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Atlanta-Resilience-Strategy-English.pdf.

"Atlanta WRMP 2022." Metropolitan North Georgia Water Planning District. (2022). *Water Resources Management Plan.* https://northgeorgiawater.org/wp-content/uploads/2015/05/2022.12.14-%E2%80%93-2022-Water-Resources-Management-Plan.pdf.

"Auckland CAP 2020." Auckland Council. (2020). *Auckland's Climate Plan.* https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/topic-based-plans-strategies/environmental-plans-strategies/aucklands-climate-plan/Documents/auckland-climate-plan.pdf.

"Auckland DP 2023." Watercare. (2023). *Auckland Drought Management Plan.* https://wslpwstoreprd.blob.core.windows.net/kentico-media-libraries-prod/watercarepublicweb/media/watercare-media-library-2/water%20supply/drought_management_plan_2023.pdf.

"Auckland Water Allocation 2012." Auckland Council. (2012). *Water Allocation.* http://www.aucklandcity.govt.nz/council/documents/regionalplans/airlandwater/Proposed%20ALWP%20-%20Part%203%20-%20Chapter%206%20Water%20Allocation.pdf.
"Auckland Water Strategy 2022." Auckland Council. (2022). *Auckland Water Strategy Implementation Plan.* https://www.aucklandcouncil.govt.nz/environment/looking-after-aucklands-water/aucklandwaterstrategydocuments/auckland-water-strategy-implementation-plan.pdf.
"Austin Climate Equity Plan 2020." City of Austin. (2020). *Austin Climate Equity Plan.* https://drive.google.com/file/d/1-81rSxv_iKU19qa0LEDeja7hjPPer1kE/view.
"Austin Climate Resilience Action Plan 2018." City of Austin. (2018). *Climate Resilience Action Plan for City Assets and Operations.* https://www.austintexas.gov/sites/default/files/files/Sustainability/Climate_Resilience_Action_Plan.compressed.pdf.
"Austin DP 2024." City of Austin. (2024). *City of Austin Drought Contingency Plan.* https://www.austintexas.gov/sites/default/files/files/Water/Water%20Conservation/2024%20DCP%20Final.pdf.
"Austin Hazard Mitigation Plan 2021." City of Austin. (2021). *City of Austin Hazard Mitigation Action Plan.* https://www.austintexas.gov/sites/default/files/files/HSEM/City%20of%20Austin%20HMAP%20Update-9.15.2021-9.14.2026-PUBLIC%20COPY.pdf.
"Austin RS 2023." City of Austin. (2023). *One Austin: Our Resilience Framework for Action.* https://www.austintexas.gov/sites/default/files/files/Resilience/Austin-blueprint-report.pdf.
"Austin WRMP 2018." Austin Water. (2018). *Water Forward: Integrated Water Resources Plan.* https://www.austintexas.gov/sites/default/files/files/Water/WaterForward/Water_Forward_Plan_Report_-_A_Water_Plan_for_the_Next_100_Years.pdf.
"Bangalore Plan for Infrastructure 2014." ATKINS. (2014). *Future Proofing Indian Cities: Bangalore Action Plan for Water and Sanitation Infrastructure.* https://niua.in/csc/assets/pdf/water/Action-Plan-for-Water-and-Sanitation-Infrastructure-Bangalore.pdf.
"Bengaluru CAP and RS 2023." City of Bengaluru. (2023). *Towards a Net Zero and Climate Resilience Bengaluru: Summary of the Bengaluru Climate Action and Resilience Plan.* https://drive.google.com/file/d/1e7UuZBFrRZViTANtXgCAXef4UaJxooNi/view.
"Bengaluru Water Board Vision 2018." Bengaluru Water Supply and Sanitation Board. (2018). *Bengaluru Water Board: Blueprint for the future.* https://bwssb.karnataka.gov.in/storage/pdf-files/documents/Vision%20Document%202050%20%20new.pdf.
"Bengaluru Water Supply Project 2017." Bangalore Water Supply and Sewerage Board. (2017). *Bengaluru Water Supply and Sewerage Project.* https://openjicareport.jica.go.jp/pdf/12300356_01.pdf.
"Berkeley CAP 2009." City of Berkeley. (2009). *Climate Action Plan.* https://berkeleyca.gov/sites/default/files/2022-01/Berkeley-Climate-Action-Plan.pdf.
"Berkeley RS 2016." City of Berkeley. (2016). *Resilience Strategy.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Berkeley-Resilience-Strategy-English.pdf.

"Boulder CAP 2021." City of Boulder. (2021). *Update on Climate Action Plan.* https://bouldercolorado.gov/media/3302/download?inline.
"Boulder DP 2022." City of Boulder. (2022). *City of Boulder Drought Plan 2022 Update.* https://bouldercolorado.gov/media/415/download?inline.
"Boulder Hazard Mitigation Plan 2022." Boulder OEM. (2022). *2022-2027 Boulder Hazard Mitigation Plan.* https://boulderodm.gov/wp-content/uploads/2020/12/hazard-mitigation-plan.pdf.
"Boulder Water Efficiency Plan 2024 ." City of Boulder. (2024). *City of Boulder Water Efficiency Plan.* https://bouldercolorado.gov/media/13386/download?inline.
"Bristol CAP 2020." City of Bristol. (2020) *One City Climate Strategy.* https://www.bristolonecity.com/wp-content/uploads/2020/02/one-city-climate-strategy.pdf.
"Bristol DP 2022." Bristol Water. (2022). *Bristol Water Drought Plan 2022.* https://www.bristolwater.co.uk/about-us/our-plans/planning-for-drought/.
"Bristol RS 2016." City of Bristol. (2016) *Bristol Resilience Strategy.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Bristol-Resilience-Strategy-English.pdf.
"Calgary CAP 2023." City of Calgary. (2023). *2023-2026 Climate Implementation Plan.* https://www.calgary.ca/environment/climate/implementation-plan.html?redirect=/climateplan#plan.
"Calgary DP 2023." City of Calgary. (2023). *The City of Calgary Drought Resilience Plan.* https://www.calgary.ca/water/drought.html?redirect=/droughtresilience.
"Calgary RS 2019." City of Calgary. (2019). *Resilient Calgary.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Calgary-Resilience-Strategy-English.pdf.
"Cape Town CAP 2021." City of Cape Town. (2021). *City of Cape Town Climate Action Plan.* https://resource.capetown.gov.za/documentcentre/Documents/City%20strategies%2C%20plans%20and%20frameworks/CCT_Climate_Change_Action_Plan.pdf.
"Cape Town Climate Strategy 2021." City of Cape Town. (2021). *City of Cape Town Climate Change Strategy.* https://drive.google.com/file/d/1as6qgF9NzjdkfniP_nOtnq9GoFH63oZl/view.
"Cape Town Critical Water Shortages 2017." City of Cape Town. (2017). *Critical Water Shortages Disaster Plan – Public Summary.* https://resource.capetown.gov.za/documentcentre/Documents/City%20strategies,%20plans%20and%20frameworks/Critical%20Water%20Shortages%20Disaster%20Plan%20Summary.pdf.
"Cape Town Critical Water Shortages 2018." City of Cape Town. (2018). *Annexure – Response to Cape Town's Drought.* https://resource.capetown.gov.za/documentcentre/Documents/City%20strategies,%20plans%20and%20frameworks/Cape%20Town%20Water%20Strategy.pdf.
"Cape Town RS 2019." City of Cape Town. (2019). *Cape Town Resilience Strategy.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Cape-Town-Resilience-Strategy-English.pdf.
"Cape Town Water Supply Strategy 2019." City of Cape Town. (2019). *Our Shared Water Future: Cape Town's Water Strategy.*

https://resource.capetown.gov.za/documentcentre/Documents/City%20strategies,%20plans%20and%20frameworks/Cape%20Town%20Water%20Strategy.pdf.
"Chennai CAP 2022." City of Chennai. (2022). *Chennai Climate Action Plan.* https://drive.google.com/file/d/1PqgPSTIQTKzdMyRxsyYcZDBLcNnd55rv/view.
"Chennai RS 2019." City of Chennai. (2019). *Resilient Chennai Strategy.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Chennai-Resilience-Strategy-English.pdf.
"Chennai Water Sustainability Assessment 2021." Mahindra – TERI. (2021). *Water Sustainability Assessment of Chennai Metropolitan Area.* https://www.teriin.org/sites/default/files/2021-06/Water_Sustainability_Assessment_%20of%20_Chennai.pdf.
"Christchurch CAP 2021." Christchurch City Council. (2021). *Christchurch Climate Resilience Strategy.* https://ccc.govt.nz/assets/Documents/Environment/Climate-Change/Otautahi-Christchurch-Climate-Resilience-Strategy.pdf.
"Christchurch RS 2015." Christchurch City Council. (2015). *Resilient Greater Christchurch.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Christchurch-Resilience-Strategy-English.pdf.
"Christchurch Water Bylaw 2022." Christchurch City Council. (2022). *Water Supply and Wastewater Bylaw 2022.* https://ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Bylaws/Water-Supply-and-Wastewater-Bylaw-2022.PDF.
"Christchurch Water Strategy 2019." Christchurch City Council. (2019). *Integrated Water Strategy.* https://ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Strategies/Integrated-water-strategy.pdf.
"Dallas CAP 2021." City of Dallas. (2021). *Dallas Comprehensive Environmental and Climate Action Plan.* https://www.dallasclimateaction.com/_files/ugd/349b65_e4f9a262cebf41258fd4343d9af0504f.pdf.
"Dallas DP 2019." City of Dallas. (2019). *City of Dallas 2019 Drought Contingency Plan.* https://dallascityhall.com/departments/waterutilities/dch%20documents/pdf/drought-contingency-plan.pdf.
"Dallas RS 2018." City of Dallas. (2018). *Resilient Dallas.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Dallas-Resilience-Strategy-English.pdf.
"Dallas Water Conservation Plan 2019." City of Dallas. (2019). *2019 water Conservation Plan.* https://dallascityhall.com/departments/waterutilities/DCH%20Documents/pdf/Water%20Conservation%20Plan.pdf.
"Durban CAP 2019." eThekwini Municipality. (2019). *Durban Climate Action Plan 2019: Toward Climate Resilience and Carbon Neutrality.* https://drive.google.com/file/d/1jVJn6q8yOxTmk3j0rHgbtu8nYceSKA7Z/view.
"Durban Municipal Adaptation Plans 2009." eThekwini Municipality. (2009). *Climate Change Municipal Adaptation Plan Health and Water*. https://www.durban.gov.za/storage/Documents/Environmental%20Planning%20%20Climate%20Protection%20%20Publications/Climate/Municipal%20Adaptation%20Plans%20-%20Health,%20Water%20and%20Disaster%20Management.pdf.

"Durban RS 2017." eThekwini Municipality. (2017). *Durban Resilience Strategy 2017.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Durban-Resilience-Strategy-English.pdf.

"Durban Sustainability Water 2007." eThekwini Municipality. (2007). *Durban's Sustainability Best Practice Portfolio: Water Special Edition.* https://www.durban.gov.za/storage/Documents/Environmental%20Planning%20%20Climate%20Protection%20%20Publications/Biodiversity/Sustainability%20Best%20Practice%20Special%20Edition%20Water.pdf.

"Durban Water Policy 2021." eThekwini Municipality. (2021). *eThekwini Water Policy.* https://www.durban.gov.za/storage/Documents/Policy%20and%20Documents/Water%20Policy.pdf.

"East Bay DP 2020." East Bay Municipal Utility District. (2020). *Water Shortage Contingency Plan 2020.* https://www.ebmud.com/water/about-your-water/water-supply/urban-water-management-plan.

"East Bay WRMP 2020." East Bay Municipal Utility District. (2020). *Urban Water Management Plan 2020.* https://www.ebmud.com/water/about-your-water/water-supply/urban-water-management-plan.

"El Paso CAP 2024." City of El Paso. (2024). *El Paso Regional Climate Action Plan.* https://www.elpasotexas.gov/assets/Documents/CoEP/Community-Development/Climate-Action/EP-Priority-Climate-Action-Plan-03.01.2024.pdf.

"El Paso DP 2024." El Paso Water. (2024). *Drought Contingency Plan.* https://cdnsm5-hosted.civiclive.com/UserFiles/Servers/Server_6843404/File/Conservation/Drought%20Contingency%20Plan%201.pdf.

"El Paso RS 2017." City of El Paso. (2017). *Resilient El Paso.* https://resilientcitiesnetwork.org/downloadable_resources/Network/El-Paso-Resilience-Strategy-English.pdf.

"El Paso Water Strategy 2021." El Paso Water. (2021). *2021 Integrated Water Management Strategies.* https://cdnsm5-hosted.civiclive.com/UserFiles/Servers/Server_6843404/File/Our%20Water/Water%20Planning/EPWater%202021%20IWMS%20Report.pdf.

"Honolulu CAP 2020." City and County of Honolulu. (2020). *One Climate One O'ahu.* https://static1.squarespace.com/static/5e3885654a153a6ef84e6c9c/t/6080c33e91bbf23a20b74159/1619051381131/2020-2025+Climate+Action+Plan.pdf.

"Honolulu RS 2019." City and County of Honolulu. (2019). *O'ahu Resilience Strategy.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Honolulu-Resilience-Strategy-English.pdf.

"Honolulu Water Shortage Plan 2022." Board of Water Supply. (2022). *BWS Water Shortage Response and Recovery Plan.* https://www.boardofwatersupply.com/bws/media/files/bws-water-shortage-response-recovery-plan-final-2022-11-28.pdf.

"Honolulu WRMP 2019." Board of Water Supply. (2019). *Water Master Plan.* https://www.boardofwatersupply.com/bws/media/files/bws-water-master-plan-summary-final-2019-09-23.pdf.

"Houston CAP 2020." City of Houston. (2020). *Houston Climate Action Plan.* https://drive.google.com/file/d/1ff7ZNeyIMuFD8w6zgdkuEanrC_LOn212/view.

"Houston Climate Impact Assessment 2020." ATMOS Research and Consulting. (2020). *Climate Impact Assessment for the City of Houston.* https://drive.google.com/file/d/134af2bBrCEewouzo0ED6OvqLyBPHtZHL/view.
"Houston DP 2019." Houston Public Works. (2019). *Drought Contingency Plan.* https://www.houstonpublicworks.org/drought-contingency-plan.
"Houston RS 2019." City of Houston. (2019). *Resilient Houston.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Houston-Resilience-Strategy-English.pdf.
"Houston Water Conservation 2019." Houston Public Works. (2019). *Water Conservation Plan.* https://www.houstonpublicworks.org/sites/g/files/nwywnm456/files/doc/2019_water_conservation_plan_with_ordinance_in_appendix_01132020.pdf.
"Johannesburg CAP 2021." City of Johannesburg. (2021). *City of Johannesburg Climate Action Plan March 2021.* https://drive.google.com/file/d/19YtOTvzs_Rd4KnE1igh0WYF10UtnQ-yF/view.
"Johannesburg City Resilience Profile 2022." ARUP. (2022). *City Characterisation Report: Johannesburg.* https://www.arup.com/globalassets/downloads/insights/c/city-water-resilience-approach/characterisation-report/ccr-johansburg.pdf.
"Johannesburg Water Resilience Assessment 2023." ARUP. (2023). *Water Resilience Profile: Johannesburg.* https://www.arup.com/globalassets/downloads/insights/c/city-water-resilience-approach/profile/johanesburg-water-resilience-profile.pdf.
"Johannesburg Water Security Strategy 2022." City of Johannesburg. (2022). *Johannesburg Water Security Strategy, Final Draft.* EISD Water and Biodiversity and ICLEI Africa January 2022. https://joburg.org.za/documents_/Documents/Draft%20Water%20Security%20Strategy%20Draft%20Final%20rev%2005April2022.pdf.
"LA DP 2020." Los Angeles County Waterworks Districts. (2020). *Water Shortage Contingency Plan.* https://pw.lacounty.gov/wwd/web/Documents/newsletter/2020%20WSCP%20Amendments%202022.pdf.
"LA Hazard Mitigation Plan 2018." City of Los Angeles. (2018). *City of Los Angeles 2018 Local Hazard Mitigation Plan.* https://www.ladwp.com/sites/default/files/documents/LADWP_2020_UWMP_Web.pdf.
"LA RS 2018." City of Los Angeles. (2018). *Resilient Los Angeles.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Los-Angeles-Resilience-Strategy-English.pdf.
"LA Sustainable City Plan 2019." City of Los Angeles. (2019). *LA's Green New Deal.* https://drive.google.com/file/d/1dsK9koid8E738bstvgAyOTWkV-K9vrMu/view.
"London Net Zero 2022." Element Energy. (2022). *Analysis of a Net Zero 2030 Target for Greater London.* Greater London Authority. https://drive.google.com/file/d/1X4CF06rlCy9Lwz3vs7CxMR2SlPB6WMYp/view.
"London RS 2020." Mayor of London. (2020). *London City Resilience Strategy 2020.* https://resilientcitiesnetwork.org/downloadable_resources/Network/London-Resilience-Strategy-English.pdf.
"Manchester CAP 2020." Manchester City Council. (2020). *Manchester City Council's Climate Change Action Plan 2020.*

https://www.manchester.gov.uk/info/500002/council_policies_and_strategies/3833/zero_carbon_manchester/3.
"Manchester DP 2022." United Utilities. (2022). *Final Drought Plan 2022.* https://www.unitedutilities.com/drought-plan.
"Manchester RS 2021." Greater Manchester Resilience Forum. (2021). *Greater Manchester Resilience Strategy.* https://www.greatermanchester-ca.gov.uk/media/4541/greater-manchester-resilience-strategy-2020-2030-accessible.pdf.
"Melbourne CAP 2018." City of Melbourne. (2018). *Climate Change Mitigation Strategy to 2050.* https://drive.google.com/file/d/1RvCOkzn3GmUaT1ofuP-VrwSbxb2KmXZX/view.
"Melbourne DP 2016." Melbourne Water. (2016). *Drought Response Plan: Part A.* https://www.melbournewater.com.au/water-and-environment/water-management/waterway-diversions/stream-flow-management.
"Melbourne RS 2016." City of Melbourne. (2016). *Resilient Melbourne.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Melbourne-Resilience-Strategy-English.pdf.
"Oakland CAP 2020." City of Oakland. (2020). *Oakland 2030: Equitable Climate Action Plan.* https://cao-94612.s3.us-west-2.amazonaws.com/documents/Oakland-ECAP-07-24.pdf.
"Oakland RS 2016." City of Oakland. (2016). *Resilient Oakland: It Takes a Town to Thrive.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Oakland-Resilience-Strategy-English.pdf.
"Portland 2023 DP Retrospective." Portland Water Bureau. (2023). *2023 Seasonal Water Supply – Retrospective.* https://www.portland.gov/water/documents/2023-seasonal-supply-plan-retrospective/download.
"Portland CAP 2022." City of Portland. (2022). *Climate Emergency Workplan.* https://www.portland.gov/bps/climate-action/documents/climate-emergency-workplan-2022-2025/download.
"Portland Seasonal DP 2024." Portland Water Bureau. (2024). *2024 Seasonal Water Supply Augmentation and Contingency Plan.* https://www.portland.gov/water/documents/2024-seasonal-water-supply-augmentation-and-contingency-plan/download.
"Portland WRMP 2020." Portland Water Bureau. (2020). *Water Management and Conservation Plan.* https://www.portland.gov/water/documents/water-management-and-conservation-plan/download.
"Pune CAP 2022." Vasudha Foundation. (2022). *Climate Change and Environment Action Plan of Pune District..* https://shaktifoundation.in/wp-content/uploads/2022/11/Pune-Executive-Summary-.pdf.
"Pune Groundwater Management Plan 2022." Central Ground Water Board. (2022). *Aquifer Mapping and Management of Groundwater Resources.* https://www.cgwb.gov.in/sites/default/files/2022-11/pune.pdf.
"Pune RS 2019." Pune Municipal Corporation. (2019). *Pune Resilience Strategy.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Pune-Resilience-Strategy-English.pdf.
"Pune Water Supply System 2014." Pune Municipal Corporation. (2014). *Water Supply System for Pune City: Detailed Project Report.* https://www.pmc.gov.in/sites/default/files/reports_dpr/WaterSupplySystemForPuneCity-DPR_Final_R2_14-02-14_0.pdf.

"SF CAP 2021." City and County of San Francisco. (2021). *San Francisco's Climate Action Plan 2021.* https://drive.google.com/file/d/1jOO8Nl41AmMKbLEEzXvwDSJ6eoNEtuOp/view.

"SF Hazards and Climate Resilience Plan 2020." City and Country of San Francisco. (2020). *Hazards and Climate Resilience Plan.* https://drive.google.com/file/d/1xsO2Vr_HIkqYvia8BqbumDMnsF3SMehO/view.

"SF RS 2016." City and County of San Francisco. (2016). *Resilient San Francisco: Stronger Today, Stronger Tomorrow.* https://resilientcitiesnetwork.org/downloadable_resources/Network/San-Francisco-Resilience-Strategy-English.pdf.

"SF UWMP 2020." San Francisco Water Power Sewer. (2020). *2020 Urban Water Management Plan.* https://sfpuc.org/sites/default/files/programs/UWMP_2020.pdf.

"Singapore 2018 RS." Centre for Liveable Cities. (2018). *A Resilient Singapore.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Singapore-Resilience-Strategy-English.pdf.

"Singapore PUB Innovation 2022." PUB Singapore National Water Agency. (2022). *Innovation in Water Singapore – Closing the Loops Towards More Sustainable Water.* https://www.pub.gov.sg/-/media/Images/Feature/Home/Resources/Publications/PUBInnovationMagazineIssue12_11042022.pdf.

"Singapore PUB Our Water Our Future 2020." PUB Singapore National Water Agency. (2020). *Our Water, Our Future.* https://www.pub.gov.sg/-/media/Images/Feature/Home/Resources/Publications/PUBOurWaterOurFuture.pdf.

"Singapore PUB Sustainability 2023." PUB Singapore National Water Agency. (2023). *Building Our Water Future: Sustainability Report 2023.* https://www.pub.gov.sg/-/media/PUB/PDF/To-Publish-PUB-SR-23-Final.pdf.

"Sydney DP 2022." Sydney Water. (2022). *Greater Sydney Drought Response Plan Overview.* https://water.dpie.nsw.gov.au/__data/assets/pdf_file/0006/527316/greater-sydney-water-strategy.pdf.

"Sydney Environmental Strategy 2021." https://drive.google.com/file/d/1Drvu6eTj-YPIAsB2-yVpZ7UoLMHoDDjH/view.

"Sydney RS 2018." City of Sydney. (2018). *Resilient Sydney: A strategy for city resilience 2018.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Sydney-Resilience-Strategy-English.pdf.

"Sydney Water Strategy 2022." NSW Government. (2022). *Greater Sydney Water Strategy.* https://water.dpie.nsw.gov.au/our-work/plans-and-strategies/greater-sydney-water-strategy/about/rhs-cta/greater-sydney-drought-response-plan.

"Thames Water DP 2022." Thames Water. (2022). *Drought Plan 2022.* https://www.thameswater.co.uk/about-us/regulation/drought-plan.

"Vancouver CAP 2024." City of Vancouver. (2024). *Climate Change Adaptation Strategy.* https://vancouver.ca/files/cov/vancouver-climate-change-adaptation-strategy-2024-25.pdf.

"Vancouver Climate Emergency Action Plan 2020." City of Vancouver. (2020). *Climate Emergency Action Plan Summary 2020-2025.* https://drive.google.com/file/d/1Tjmi4FA5JpvLK8I6TNOIGarGHnVzqmhJ/view.

"Vancouver Drinking Water Conservation Plan 2021." City of Vancouver. (2021). *Drinking Water Conservation Plan.* https://metrovancouver.org/services/water/Documents/drinking-water-conservation-plan.pdf.

"Vancouver RS 2019." City of Vancouver. (2019). *Resilient Vancouver.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Vancouver-Resilience-Strategy-English.pdf.

"Vancouver Water Supply Outlook 2019." City of Vancouver. (2019). *Water Supply Outlook 2120.* https://metrovancouver.org/services/water/Documents/water-supply-outlook-2120.pdf.

"Wellington DP 2024." Wellington Water. (2024). *Drought Management Plan.* https://www.wellingtonwater.co.nz/assets/Reports-and-Publications/Drought-Management-Plan-Wellington-Metropolitan-Area-2024.pdf.

"Wellington RS 2017." Wellington City Council. (2017). *Wellington Resilience Strategy.* https://resilientcitiesnetwork.org/downloadable_resources/Network/Wellington-Resilience-Strategy-English.pdf.

"Wellington Zero Carbon Implementation 2020." Wellington City Council. (2020). *Te Atakura First to Zero - Wellington City's Zero Carbon Implementation Plan 2020–2030.* https://wellington.govt.nz/-/media/environment-and-sustainability/climate-change/files/te-atakura-first-zero-implentation-plan.pdf?la=en&hash=E7577A5F1360A99100C7CD773E2533470CF22D39.

"Wellington Zero Carbon Plan 2019." Wellington City Council. (2019). *Our City Tomorrow: Te Atakura First to Zero Wellington's blueprint for a Zero Carbon Capital.* https://wellington.govt.nz/-/media/environment-and-sustainability/climate-change/files/zero-carbon-plan-final-web.pdf?la=en&hash=49A63C825646783F06FB13D9AB708AF984324492.

Acuto, M. (2013). The new climate leaders? *Review of International Studies*, *39*(4), 835–857. https://doi.org/10.1017/S0260210512000502

Acuto, M., & Ghojeh, M. (2019). C40 Cities Inside Out. *Global Policy*, *10*(4), 709–711. https://doi.org/10.1111/1758-5899.12760

Aguilar-Barajas, I., Sisto, N. P., Magaña-Rueda, V., Ramírez, A. I., & Mahlknecht, J. (2016). Drought policy in Mexico: A long, slow march toward an integrated and preventive management model. *Water Policy*, *18*(S2), 107–121. https://doi.org/10.2166/wp.2016.116

Aguilera-Klink, F., Pérez-Moriana, E., & Sánchez-García, J. (2000). The social construction of scarcity. The case of water in Tenerife (Canary Islands). *Ecological Economics*, *34*(2), 233–245. https://doi.org/10.1016/S0921-8009(00)00160-9

Alves, P. B. R., Loc, H. H., De Silva, Y., Penny, J., Babel, M., & Djordjévic, S. (2023). The dual-risks context: A systematic literature review for the integrated management of flood and drought risks. *International Journal of Disaster Risk Reduction*, *96*, 103905. https://doi.org/10.1016/j.ijdrr.2023.103905

American Planning Association. (2019). *A Planner's Guide to Drought and Cascading Impacts*.

Araos, M., Berrang-Ford, L., Ford, J. D., Austin, S. E., Biesbroek, R., & Lesnikowski, A. (2016). Climate change adaptation planning in large cities: A systematic global assessment. *Environmental Science & Policy*, *66*, 375–382. https://doi.org/10.1016/j.envsci.2016.06.009

Aylett, A. (2015). Institutionalizing the urban governance of climate change adaptation: Results of an international survey. *Urban Climate*, *14*, 4–16. https://doi.org/10.1016/j.uclim.2015.06.005

Baccour, S., Goelema, G., Kahil, T., Albiac, J., van Vliet, M. T. H., Zhu, X., & Strokal, M. (2024). Water quality management could halve future water scarcity cost-effectively in the Pearl River Basin. *Nature Communications*, *15*(1), 5669. https://doi.org/10.1038/s41467-024-49929-z

Baxter, J. (2020). Health and Environmental Risk. In A. Kobayashi (Ed.), *International Encyclopedia of Human Geography (Second Edition)* (pp. 303–307). Elsevier. https://doi.org/10.1016/B978-0-08-102295-5.10440-8

Berbel, J., & Esteban, E. (2019). Droughts as a catalyst for water policy change. Analysis of Spain, Australia (MDB), and California. *Global Environmental Change*, *58*, 101969. https://doi.org/10.1016/j.gloenvcha.2019.101969

Berg-Schlosser, D., & Meur, G. D. (2009). Comparative Research Design: Case and Variable Selection. *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques*, 19–32. https://doi.org/10.4135/9781452226569.n2

Berke, P., Newman, G., Lee, J., Combs, T., Kolosna, C., & Salvesen, D. (2015). Evaluation of Networks of Plans and Vulnerability to Hazards and Climate Change: A Resilience Scorecard. *Journal of the American Planning Association*, *81*(4), 287–302. https://doi.org/10.1080/01944363.2015.1093954

Betsill, M., & Bulkeley, H. (2007). Looking Back and Thinking Ahead: A Decade of Cities and Climate Change Research. *Local Environment*, *12*(5), 447–456. https://doi.org/10.1080/13549830701659683

Bettini, Y., Brown, R., & de Haan, F. (2015). Exploring institutional adaptive capacity in practice: Examining water governance adaptation in Australia. *Ecology and Society*, *20*(1). https://doi.org/10.5751/ES-07291-200147

Biswas, A. K., & Tortajada, C. (2010). Future Water Governance: Problems and Perspectives. *International Journal of Water Resources Development*, *26*(2), 129–139. https://doi.org/10.1080/07900627.2010.488853

Bouteligier, S. (2013). Inequality in new global governance arrangements: The North–South divide in transnational municipal networks. *Innovation: The European Journal of Social Science Research*, *26*(3), 251–267. https://doi.org/10.1080/13511610.2013.771890

Braun, B. P. (2014). A New Urban Dispositif? Governing Life in an Age of Climate Change. *Environment and Planning D: Society and Space*, *32*(1), 49–64. https://doi.org/10.1068/d4313

Brennan, D., Tapsuwan, S., & Ingram, G. (2007). The welfare costs of urban outdoor water restrictions. *Australian Journal of Agricultural and Resource Economics*, *51*(3), 243–261. https://doi.org/10.1111/j.1467-8489.2007.00395.x

Bruns, A., & Frick-Trzebitzky, F. (2014). *The Notion of the Global Water Crisis and Urban Water Realities* (pp. 415–426).

Bulkeley, H. (2010). Cities and the Governing of Climate Change. *Annual Review of Environment and Resources*, *35*(Volume 35, 2010), 229–253. https://doi.org/10.1146/annurev-environ-072809-101747

Buurman, J., Mens, M. J. P., & Dahm, R. J. (2017). Strategies for urban drought risk management: A comparison of 10 large cities. *International Journal of Water Resources Development*, *33*(1), 31–50. https://doi.org/10.1080/07900627.2016.1138398

C40. (2022, January). *C40 Cities with a Paris Climate Agreement compatible CAP*. C40 Cities. https://www.google.com/maps/d/viewer?mid=1hR77I4BWAhKAb805TrazOV__2DBsxUZ7

C40 Cities. (2022a, June). *Drought—Water Safe Cities*. C40 Cities. https://www.c40.org/water-safe-cities/drought/

C40 Cities. (2022b, June). *Water Safe Cities: Technical Report*. https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/1Q000000ZjNF/NQMDUgqZ_Mcr3hqAYY2bicKH_K17ttVGJyVnDJpypWM

Cai, J., Kummu, M., Niva, V., Guillaume, J. H. A., & Varis, O. (2018). Exposure and resilience of China's cities to floods and droughts: A double-edged sword. *International Journal of Water Resources Development*, *34*(4), 547–565. https://doi.org/10.1080/07900627.2017.1353411

Cantor, A. (2021). Hydrosocial hinterlands: An urban political ecology of Southern California's hydrosocial territory. *Environment and Planning E: Nature and Space*, *4*(2), 451–474. https://doi.org/10.1177/2514848620909384

Celio, M., Scott, C. A., & Giordano, M. (2010). Urban–agricultural water appropriation: The Hyderabad, India case. *The Geographical Journal*, *176*(1), 39–57. https://doi.org/10.1111/j.1475-4959.2009.00336.x

Cooper, B., Burton, M., & Crase, L. (2011). Urban water restrictions: Attitudes and avoidance. *Water Resources Research*, *47*(12). https://doi.org/10.1029/2010WR010226

Crausbay, S. D., Betancourt, J., Bradford, J., Cartwright, J., Dennison, W. C., Dunham, J., Enquist, C. A. F., Frazier, A. G., Hall, K. R., Littell, J. S., Luce, C. H., Palmer, R., Ramirez, A. R., Rangwala, I., Thompson, L., Walsh, B. M., & Carter, S. (2020). Unfamiliar Territory: Emerging Themes for Ecological Drought Research and Management. *One Earth*, *3*(3), 337–353. https://doi.org/10.1016/j.oneear.2020.08.019

Cravens, A. E., Henderson, J., Friedman, J., Burkardt, N., Cooper, A. E., Haigh, T., Hayes, M., McEvoy, J., Paladino, S., Wilke, A. K., & Wilmer, H. (2021). A typology of drought decision making: Synthesizing across cases to understand drought preparedness and response actions. *Weather and Climate Extremes*, *33*, 100362. https://doi.org/10.1016/j.wace.2021.100362

Davidson, K., & Gleeson, B. (2015). Interrogating Urban Climate Leadership: Toward a Political Ecology of the C40 Network. *Global Environmental Politics*, *15*(4), 21–38. https://doi.org/10.1162/GLEP_a_00321

Del Moral Ituarte, L., & Giansante, C. (2000). Constraints to Drought Contingency Planning in Spain: The Hydraulic Paradigm and the Case of Seville. *Journal of Contingencies and Crisis Management*, *8*(2), 93–102. https://doi.org/10.1111/1468-5973.00128

DeLyser, D., Herbert, S., Aitken, S. C., Crang, M. A., & McDowell, L. (2009). *The SAGE Handbook of Qualitative Geography*. SAGE Publications, Limited. http://ebookcentral.proquest.com/lib/oxford/detail.action?docID=743488

Desbureaux, S., & Rodella, A.-S. (2019). Drought in the city: The economic impact of water scarcity in Latin American metropolitan areas. *World Development*, *114*, 13–27. https://doi.org/10.1016/j.worlddev.2018.09.026

Deyà Tortella, B., & Tirado, D. (2011). Hotel water consumption at a seasonal mass tourist destination. The case of the island of Mallorca. *Journal of Environmental Management*, *92*(10), 2568–2579. https://doi.org/10.1016/j.jenvman.2011.05.024

Dilling, L., Daly, M. E., Kenney, D. A., Klein, R., Miller, K., Ray, A. J., Travis, W. R., & Wilhelmi, O. (2019). Drought in urban water systems: Learning lessons for climate adaptive capacity. *Climate Risk Management*, *23*, 32–42. https://doi.org/10.1016/j.crm.2018.11.001

Dong, X., Jiang, L., Zeng, S., Guo, R., & Zeng, Y. (2020). Vulnerability of urban water infrastructures to climate change at city level. *Resources, Conservation and Recycling*, *161*, 104918. https://doi.org/10.1016/j.resconrec.2020.104918

dos Santos, A. P. S., & Puppim de Oliveira, J. A. (2024). What factors drive municipal climate adaptation policy? The role of risk management capacity and transnational municipal networks. *Urban Climate*, *53*, 101809. https://doi.org/10.1016/j.uclim.2024.101809

Dracup, J. A., Lee, K. S., & Paulson Jr., E. G. (1980). On the definition of droughts. *Water Resources Research*, *16*(2), 297–302. https://doi.org/10.1029/WR016i002p00297

Dumała, H., Łuszczuk, M., Piwowarczyk, J., & Zieliński, T. (2021). Transnational Municipal Networks as a Mechanism for Marine Governance Toward Climate Change Adaptation and Mitigation: Between Potential and Practice. *Frontiers in Marine Science*, *8*. https://doi.org/10.3389/fmars.2021.626119

Durley, J. L., & de Loë, R. C. (2005). Empowering communities to carry out drought contingency planning. *Water Policy*, *7*(6), 551–567. https://doi.org/10.2166/wp.2005.0033

Elie, M. (2024). Toward a complex socio-environmental understanding of drought: The contribution of the social sciences and humanities. *WIREs Climate Change*, *n/a*(n/a), e907. https://doi.org/10.1002/wcc.907

Engle, N. L. (2013). The role of drought preparedness in building and mobilizing adaptive capacity in states and their community water systems. *Climatic Change*, *118*(2), 291–306. https://doi.org/10.1007/s10584-012-0657-4

Entman, R. (1993). Framing: Toward Clarification of A Fractured Paradigm. *The Journal of Communication*, *43*, 51–58. https://doi.org/10.1111/j.1460-2466.1993.tb01304.x

Fielding, K. S., Russell, S., Spinks, A., & Mankad, A. (2012). Determinants of household water conservation: The role of demographic, infrastructure, behavior, and psychosocial variables. *Water Resources Research*, *48*(10), 2012WR012398. https://doi.org/10.1029/2012WR012398

Finley, S. L., & Basu, N. B. (2020). Curbing the Summer Surge: Permanent Outdoor Water Use Restrictions in Humid and Semiarid Cities. *Water Resources Research*, *56*(8), e2019WR026466. https://doi.org/10.1029/2019WR026466

Finnessey, T., Hayes, M., Lukas, J., & Svoboda, M. (2016). Using climate information for drought planning. *Climate Research*, *70*(2–3), 251–263. https://doi.org/10.3354/cr01406

Fleming-Muñoz, D. A., Whitten, S., & Bonnett, G. D. (2023). The economics of drought: A review of impacts and costs. *Australian Journal of Agricultural and Resource Economics*, *67*(4), 501–523. https://doi.org/10.1111/1467-8489.12527

Flörke, M., Schneider, C., & McDonald, R. I. (2018). Water competition between cities and agriculture driven by climate change and urban growth. *Nature Sustainability*, *1*(1), 51–58. https://doi.org/10.1038/s41893-017-0006-8

Fontaine, M. M., Steinemann, A. C., & Hayes, M. J. (2014). State Drought Programs and Plans: Survey of the Western United States. *Natural Hazards Review*, *15*(1), 95–99. https://doi.org/10.1061/(ASCE)NH.1527-6996.0000094

Ford, J. D., & Berrang-Ford, L. (2016). The 4Cs of adaptation tracking: Consistency, comparability, comprehensiveness, coherency. *Mitigation and Adaptation Strategies for Global Change*, *21*(6), 839–859. https://doi.org/10.1007/s11027-014-9627-7

Forero-Ortiz, E., Martínez-Gomariz, E., & Monjo, R. (2020). Climate Change Implications for Water Availability: A Case Study of Barcelona City. *Sustainability*, *12*(5), Article 5. https://doi.org/10.3390/su12051779

Foucault, M. (1982). The Subject and Power. *Critical Inquiry*, *8*(4), 777–795.

Fu, X., Svoboda, M., Tang, Z., Dai, Z., & Wu, J. (2013). An overview of US state drought plans: Crisis or risk management? *Natural Hazards*, *69*(3), 1607–1627. https://doi.org/10.1007/s11069-013-0766-z

Fu, X., Tang, Z., Wu, J., & McMillan, K. (2013). Drought planning research in the United States: An overview and outlook. *International Journal of Disaster Risk Science*, *4*(2), 51–58. https://doi.org/10.1007/s13753-013-0006-x

Gabarda-Mallorquí, A., & Ribas Palom, A. (2016). Understanding reductions in water consumption in tourist areas: A case study of the Costa Brava, Spain. *International Journal of Water Resources Development*, *32*(6), 912–930. https://doi.org/10.1080/07900627.2016.1142861

Garcia, R. V. (2016). *Nature Pleads Not Guilty: The 1972 Case History*. Elsevier.

Garrick, D. (2018). Decentralisation and drought adaptation: Applying the subsidiarity principle in transboundary river basins. *International Journal of the Commons*, *12*(1). https://ora.ox.ac.uk/objects/uuid:9cebbeb5-ad29-4327-bd0a-db2c67b8b3b3

Garrick, D., Stefano, L. D., Yu, W., Jorgensen, I., O'Donnell, E., Turley, L., Aguilar-Barajas, I., Dai, X., Leão, R. de S., Punjabi, B., Schreiner, B., Svensson, J., & Wight, C. (2019). Rural water for thirsty cities: A systematic review of water reallocation from rural to urban regions. *Environmental Research Letters*, *14*(4), 043003. https://doi.org/10.1088/1748-9326/ab0db7

Ghosh, S., Sharma, S., Ghosh, S. K., Pal, B., Kanthal, S., & Roy, S. (2022). Unconventional Water Production Technologies for a smart and sustainable society. *Journal of Physics: Conference Series*, *2286*(1), 012029. https://doi.org/10.1088/1742-6596/2286/1/012029

Gilligan, J. M., Wold, C. A., Worland, S. C., Nay, J. J., Hess, D. J., & Hornberger, G. M. (2018). Urban Water Conservation Policies in the United States. *Earth's Future*, *6*(7), 955–967. https://doi.org/10.1029/2017EF000797

Gleick, P. H., Pacific Institute for Studies in Development, E., & Stockholm Environment Institute. (1993). *Water in crisis: A guide to the world's fresh water resources*. Oxford University Press.

Gnann, S., Reinecke, R., Stein, L., Wada, Y., Thiery, W., Müller Schmied, H., Satoh, Y., Pokhrel, Y., Ostberg, S., Koutroulis, A., Hanasaki, N., Grillakis, M., Gosling, S. N., Burek, P., Bierkens, M. F. P., & Wagener, T. (2023). Functional relationships reveal differences in the water cycle representation of global water models. *Nature Water*, *1*(12), 1079–1090. https://doi.org/10.1038/s44221-023-00160-y

Gober, P. (2010). Desert urbanization and the challenges of water sustainability. *Current Opinion in Environmental Sustainability*, *2*(3), 144–150. https://doi.org/10.1016/j.cosust.2010.06.006

Goffman, E. (1974). *Frame analysis: An essay on the organization of experience* (pp. ix, 586). Harvard University Press.

Gómez Gómez, C. M., & Pérez Blanco, C. D. (2012). Do drought management plans reduce drought risk? A risk assessment model for a Mediterranean river basin. *Ecological Economics*, *76*, 42–48. https://doi.org/10.1016/j.ecolecon.2012.01.008

Grecksch, K. (2018). *Running Out of Water and Options? An Assessment of Current Drought and Water Scarcity Management Options in England and Wales* (SSRN Scholarly Paper ID 3245965). Social Science Research Network. https://papers.ssrn.com/abstract=3245965

Grecksch, K., & Landström, C. (2021). Drought and Water Scarcity Management Policy in England and Wales—Current Failings and the Potential of Civic Innovation. *Frontiers in Environmental Science*, *9*. https://doi.org/10.3389/fenvs.2021.574975

Greene, C. (2021). "Drought isn't just water, it is living": Narratives of drought vulnerability in California's San Joaquin Valley. *Geoforum*, *121*, 33–43. https://doi.org/10.1016/j.geoforum.2021.02.007

Greve, P., Kahil, T., Mochizuki, J., Schinko, T., Satoh, Y., Burek, P., Fischer, G., Tramberend, S., Burtscher, R., Langan, S., & Wada, Y. (2018). Global assessment of water challenges under uncertainty in water scarcity projections. *Nature Sustainability*, *1*(9), 486–494. https://doi.org/10.1038/s41893-018-0134-9

Guerreiro, S. B., Dawson, R. J., Kilsby, C., Lewis, E., & Ford, A. (2018). Future heat-waves, droughts and floods in 571 European cities. *Environmental Research Letters*, *13*(3), 034009. https://doi.org/10.1088/1748-9326/aaaad3

Güneralp, B., Güneralp, İ., & Liu, Y. (2015). Changing global patterns of urban exposure to flood and drought hazards. *Global Environmental Change*, *31*, 217–225. https://doi.org/10.1016/j.gloenvcha.2015.01.002

Gutiérrez, A. P. A., Engle, N. L., De Nys, E., Molejón, C., & Martins, E. S. (2014). Drought preparedness in Brazil. *Weather and Climate Extremes*, *3*, 95–106. https://doi.org/10.1016/j.wace.2013.12.001

Haigh, T., Wickham, E., Hamlin, S., & Knutson, C. (2022). Planning Strategies and Barriers to Achieving Local Drought Preparedness. *Journal of the American Planning Association*, 1–15. https://doi.org/10.1080/01944363.2022.2071324

Hall, J. W., & Leng, G. (2019). Can we calculate drought risk… and do we need to? *WIREs Water*, *6*(4), e1349. https://doi.org/10.1002/wat2.1349

Hall, M. (2014). *Promoting Drought Resilience Through Plans and Codes*. https://planning-org-uploaded-media.s3.amazonaws.com/document/ZoningPractice201404.pdf

He, C., Liu, Z., Wu, J., Pan, X., Fang, Z., Li, J., & Bryan, B. A. (2021). Future global urban water scarcity and potential solutions. *Nature Communications*, *12*(1), 4667. https://doi.org/10.1038/s41467-021-25026-3

Heidrich, O., Dawson, R. J., Reckien, D., & Walsh, C. L. (2013). Assessment of the climate preparedness of 30 urban areas in the UK. *Climatic Change*, *120*(4), 771–784. https://doi.org/10.1007/s10584-013-0846-9

Heikkinen, M., Karimo, A., Klein, J., Juhola, S., & Ylä-Anttila, T. (2020). Transnational municipal networks and climate change adaptation: A study of 377 cities. *Journal of Cleaner Production*, *257*, 120474. https://doi.org/10.1016/j.jclepro.2020.120474

Heikkinen, M., Ylä-Anttila, T., & Juhola, S. (2019). Incremental, reformistic or transformational: What kind of change do C40 cities advocate to deal with climate change? *Journal of Environmental Policy & Planning*, *21*(1), 90–103. https://doi.org/10.1080/1523908X.2018.1473151

Hensher, D., Shore, N., & Train, K. (2006). Water Supply Security and Willingness to Pay to Avoid Drought Restrictions. *Economic Record*, *82*(256), 56–66. https://doi.org/10.1111/j.1475-4932.2006.00293.x

Herod, A., & Wright, M. W. (2002). *Geographies of Power: Placing Scale*. John Wiley & Sons, Incorporated. http://ebookcentral.proquest.com/lib/oxford/detail.action?docID=351158

Hoekstra, A. Y., Buurman, J., & Ginkel, K. C. H. van. (2018). Urban water security: A review. *Environmental Research Letters*, *13*(5), 053002. https://doi.org/10.1088/1748-9326/aaba52

Hooper, V. (2015). *The importance of the 'urban' in agricultural-to-urban water transfers: Insights from comparative research in India and China* [Doctoral, University of East Anglia. School of International Development]. https://ueaeprints.uea.ac.uk/id/eprint/58493/

Hopkins, L. D., & Knaap, G.-J. (2018). Autonomous planning: Using plans as signals. *Planning Theory*, *17*(2), 274–295. https://doi.org/10.1177/1473095216669868

Hornberger, G. M., Hess, D. J., & Gilligan, J. (2015). Water conservation and hydrological transitions in cities in the United States. *Water Resources Research*, *51*(6), 4635–4649. https://doi.org/10.1002/2015WR016943

Huck, A., Monstadt, J., & Driessen, P. (2020). Mainstreaming resilience in urban policy making? Insights from Christchurch and Rotterdam. *Geoforum*, *117*, 194–205. https://doi.org/10.1016/j.geoforum.2020.10.001

Huff, A., & Mehta, L. (2019). Untangling Scarcity. In *Scarcity in the Modern World*. http://www.bloomsburycollections.com.ezproxy-prd.bodleian.ox.ac.uk/collections/monograph

Jon, I., & Reghezza-Zitt, M. (2020). Late Modernity to Postmodern? The Rise of Global Resilience and its Progressive Potentials for Local Disaster Planning (Seattle and Paris). *Planning Theory & Practice*, *21*(1), 94–122. https://doi.org/10.1080/14649357.2019.1692896

Kaika, M. (2003). Constructing Scarcity and Sensationalising Water Politics: 170 Days That Shook Athens. *Antipode*, *35*(5), 919–954. https://doi.org/10.1111/j.1467-8330.2003.00365.x

Kallis, G. (2010). Coevolution in water resource development: The vicious cycle of water supply and demand in Athens, Greece. *Ecological Economics*, *69*(4), 796–809. https://doi.org/10.1016/j.ecolecon.2008.07.025

Kallis, G., & Coccossis, H. (2002). Water for the City: Lessons from Tendencies and Critical Issues in Five Advanced Metropolitan Areas. *Built Environment (1978-)*, *28*(2), 96–110.

Kamiński, T. (2023). Southeast Asian cities as co-producers of ecological knowledge in transnational city networks. *Singapore Journal of Tropical Geography*, *44*(1), 58–74. https://doi.org/10.1111/sjtg.12465

Karimidastenaei, Z., Avellán, T., Sadegh, M., Kløve, B., & Haghighi, A. T. (2022). Unconventional water resources: Global opportunities and challenges. *Science of The Total Environment*, *827*, 154429. https://doi.org/10.1016/j.scitotenv.2022.154429

Kenney, D. S. (2014). Understanding utility disincentives to water conservation as a means of adapting to climate change pressures. *Journal (American Water Works Association)*, *106*(1), 36–46.

Khalid, A. M., & Okitasari, M. (2023). Enabling effective climate action plans at city level: Insights from India's metropolitan cities. *Sustainable Cities and Society*, *98*, 104812. https://doi.org/10.1016/j.scs.2023.104812

Khmara, Y., & Kronenberg, J. (2023). On the road to urban degrowth economics? Learning from the experience of C40 cities, doughnut cities, Transition Towns, and shrinking cities. *Cities*, *136*, 104259. https://doi.org/10.1016/j.cities.2023.104259

Koppen, B. van. (2023). *Restoring the Commons: A Gendered Analysis of Customary Water Tenure in Sub-Saharan Africa* (1). *17*(1), Article 1. https://doi.org/10.5334/ijc.1164

Krippendorff, K. (2018). *Content Analysis: An Introduction to Its Methodology*. SAGE Publications.

Kuper, M., Mayaux, P.-L., & Benmihoub, A. (2023). *The Persistent Appeal of the California Agricultural Dream in North Africa*. *16*(1).

Kuzma, S., Saccoccia, L., & Chertock, M. (2023). *25 Countries, Housing One-quarter of the Population, Face Extremely High Water Stress*. https://www.wri.org/insights/highest-water-stressed-countries

Laeni, N., van den Brink, M., & Arts, J. (2019). Is Bangkok becoming more resilient to flooding? A framing analysis of Bangkok's flood resilience policy combining insights from both insiders and outsiders. *Cities*, *90*, 157–167. https://doi.org/10.1016/j.cities.2019.02.002

Lange, B., & Cook, C. (2015). Mapping a Developing Governance Space: Managing Drought in the UK. *Current Legal Problems*, *68*(1), 1–38. https://doi.org/10.1093/clp/cuv014

Lee, T. (2019). Network comparison of socialization, learning and collaboration in the C40 cities climate group. *Journal of Environmental Policy & Planning*, *21*(1), 104–115. https://doi.org/10.1080/1523908X.2018.1433998

Lee, T., & Koski, C. (2014). Mitigating Global Warming in Global Cities: Comparing Participation and Climate Change Policies of C40 Cities. *Journal of Comparative Policy Analysis: Research and Practice*, *16*(5), 475–492. https://doi.org/10.1080/13876988.2014.910938

Lee, T., & Painter, M. (2015). Comprehensive local climate policy: The role of urban governance. *Urban Climate*, *14*, 566–577. https://doi.org/10.1016/j.uclim.2015.09.003

Lee, T., & van de Meene, S. (2012). Who teaches and who learns? Policy learning through the C40 cities climate network. *Policy Sciences*, *45*(3), 199–220. https://doi.org/10.1007/s11077-012-9159-5

Li, J., Song, S., Ayantobo, O. O., Wang, H., Jiaping, L., & Zhang, B. (2022). Coordinated allocation of conventional and unconventional water resources considering uncertainty and different stakeholders. *Journal of Hydrology*, *605*, 127293. https://doi.org/10.1016/j.jhydrol.2021.127293

Lin, J., Qian, T., & Schubert, S. (2022). Droughts and Mega-Droughts. *Atmosphere-Ocean*, *60*(3–4), 245–306. https://doi.org/10.1080/07055900.2022.2086848

Lindsay, J., Dean, A. J., & Supski, S. (2017). Responding to the Millennium drought: Comparing domestic water cultures in three Australian cities. *Regional Environmental Change*, *17*(2), 565–577. https://doi.org/10.1007/s10113-016-1048-6

Linton, J., & Saadé, M. (2024). *Global Water and Its (Anti)Political Consequences*. *17*(2).

Loftus, A., & March, H. (2019). Integrating what and for whom? Financialisation and the Thames Tideway Tunnel. *Urban Studies*, *56*(11), 2280–2296. https://doi.org/10.1177/0042098017736713

Lohmeyer, R., Buckstaff, B., & Longhi, M. (2023). *The distributed geography of opportunity: The 2023 Global Cities Report*. Kearny. https://www.kearney.com/service/global-business-policy-council/gcr/2023-full-report

Long, J., & Rice, J. L. (2019). From sustainable urbanism to climate urbanism. *Urban Studies*, *56*(5), 992–1008. https://doi.org/10.1177/0042098018770846

Makaya, E., Rohse, M., Day, R., Vogel, C., Mehta, L., McEwen, L., Rangecroft, S., & Van Loon, A. (2020). *Water Governance Challenges in Rural South Africa: Exploring Institutional Coordination in Drought Management*. https://doi.org/10.2166/wp.2020.234

Malthus, T. R. (2000). *Essay on the Principle of Population*. Electric Book Company. http://ebookcentral.proquest.com/lib/oxford/detail.action?docID=3008464

Matrosov, E. S., Huskova, I., Kasprzyk, J. R., Harou, J. J., Lambert, C., & Reed, P. M. (2015). Many-objective optimization and visual analytics reveal key trade-offs for London's water supply. *Journal of Hydrology*, *531*, 1040–1053. https://doi.org/10.1016/j.jhydrol.2015.11.003

McDonald, R. I., Douglas, I., Revenga, C., Hale, R., Grimm, N., Grönwall, J., & Fekete, B. (2011). Global Urban Growth and the Geography of Water Availability, Quality, and Delivery. *AMBIO*, *40*(5), 437–446. https://doi.org/10.1007/s13280-011-0152-6

McDonald, R. I., Weber, K., Padowski, J., Flörke, M., Schneider, C., Green, P. A., Gleeson, T., Eckman, S., Lehner, B., Balk, D., Boucher, T., Grill, G., & Montgomery, M. (2014). Water on an urban planet: Urbanization and the reach of urban water infrastructure. *Global Environmental Change*, *27*, 96–105. https://doi.org/10.1016/j.gloenvcha.2014.04.022

McEvoy, J. (2014). *Desalination and Water Security: The Promise and Perils of a Technological Fix to the Water Crisis in Baja California Sur, Mexico*. *7*(3).

McEvoy, J. (2015). Can the Adoption of Desalination Technology Lead to Aquifer Preservation? A Case Study of a Sociotechnical Water System in Baja California Sur, Mexico. *Water*, *7*(10), 5224–5238. https://doi.org/10.3390/w7105224

McHugh, M. L. (2012). Interrater reliability: The kappa statistic. *Biochemia Medica*, *22*(3), 276–282.

McQuail, D. (1987). *Mass communication theory: An introduction* (pp. xvi, 352). Sage Publications, Inc.

Meerow, S., Hannibal, B., Woodruff, S. C., Roy, M., Matos, M., & Gilbertson, P. C. (2024). Urban Flood Resilience Networks: Exploring the Relationship between Governance Networks, Networks of Plans, and Spatial Flood Resilience Policies in Four Coastal Cities. *Annals of the American Association of Geographers*, *0*(0), 1–11. https://doi.org/10.1080/24694452.2023.2284299

Meerow, S., & Neuner, F. G. (2021). Positively Resilient? How Framing Local Action Affects Public Opinion. *Urban Affairs Review*, *57*(1), 70–103. https://doi.org/10.1177/1078087420905655

Meerow, S., & Stults, M. (2016). Comparing Conceptualizations of Urban Climate Resilience in Theory and Practice. *Sustainability*, *8*(7), Article 7. https://doi.org/10.3390/su8070701

Mehta, L. (2003). Contexts and Constructions of Water Scarcity. *Economic and Political Weekly*, *38*(48), 5066–5072.

Mehta, L., Huff, A., & Allouche, J. (2019). The new politics and geographies of scarcity. *Geoforum*, *101*, 222–230. https://doi.org/10.1016/j.geoforum.2018.10.027

Milman, A., & Kiparsky, M. (2020). *Concurrent Governance Processes of California's Sustainable Groundwater Management Act*. https://doi.org/10.1080/08941920.2020.1725696

Mishra, A. K., & Singh, V. P. (2010). A review of drought concepts. *Journal of Hydrology*, *391*(1), 202–216. https://doi.org/10.1016/j.jhydrol.2010.07.012

Molle, F., & Berkoff, D. (2006). *Cities Versus Agriculture: Revisiting Intersectoral Water Transfers, Potential Gains and Conflicts*. *10*.

Molle, F., Wester, P., & Hirsch, P. (2010). River basin closure: Processes, implications and responses. *Agricultural Water Management*, *97*(4), 569–577. https://doi.org/10.1016/j.agwat.2009.01.004

Moore, M., Chaney, P. L., Brantley, E., & Burton, C. G. (2021). Drought Management Plans of Major Cities in Alabama v. California. *Southeastern Geographer*, *61*(1), 31–48. https://doi.org/10.1353/sgo.2021.0003

Muller, M. (2018). Cape Town's drought: Don't blame climate change. *Nature*, *559*(7713), 174–176. https://doi.org/10.1038/d41586-018-05649-1

Müller, W. (2020). Drought Victims Demand Justice: Politicization of Drought by Farmers in Southern Germany over Time. *Water*, *12*(3), Article 3. https://doi.org/10.3390/w12030871

Müller, W., & Kruse, S. (2021). Modes of drought climatization: A frame analysis of drought problematization in Germany across policy fields. *Environmental Policy and Governance*, *31*(5), 546–559. https://doi.org/10.1002/eet.1954

Mullin, M., & Rubado, M. E. (2017). Local Response to Water Crisis: Explaining Variation in Usage Restrictions During a Texas Drought. *Urban Affairs Review*, *53*(4), 752–774. https://doi.org/10.1177/1078087416657199

Muñoz-Erickson, T. A., Meerow, S., Hobbins, R., Cook, E., Iwaniec, D. M., Berbés-Blázquez, M., Grimm, N. B., Barnett, A., Cordero, J., Gim, C., Miller, T. R., Tandazo-Bustamante, F., & Robles-Morua, A. (2021). Beyond bouncing back? Comparing and contesting urban resilience frames in US and Latin American contexts. *Landscape and Urban Planning*, *214*, 104173. https://doi.org/10.1016/j.landurbplan.2021.104173

Nemati, M., Tran, D., & Schwabe, K. (2023). Residential Water Conservation and the Rebound Effect: A Temporal Decomposition and Investigation. *Water Resources Research*, *59*(4), e2022WR032169. https://doi.org/10.1029/2022WR032169

Nordgren, J., Stults, M., & Meerow, S. (2016). Supporting local climate change adaptation: Where we are and where we need to go. *Environmental Science & Policy*, *66*, 344–352. https://doi.org/10.1016/j.envsci.2016.05.006

O'Lear, S., Dalby, S., Johnson, C., & VanDeveer, S. D. (2020). *Chapter 11: Looking ahead: environmental geopolitics research*. https://www-elgaronline-com.ezproxy-prd.bodleian.ox.ac.uk/edcollchap/edcoll/9781788971232/9781788971232.00019.xml

Oliver-Smith, A., Hoffman, S., & Hoffman, S. M. (1999). *The Angry Earth: Disaster in Anthropological Perspective*. Routledge.

Omari Motsumi, K., Ziervogel, G., & New, M. (2023). Drought governance: A cross-level governance analysis in Botswana. *Climate Risk Management*, *42*, 100557. https://doi.org/10.1016/j.crm.2023.100557

Padowski, J. C., & Gorelick, S. M. (2014). Global analysis of urban surface water supply vulnerability. *Environmental Research Letters*, *9*(10), 104004. https://doi.org/10.1088/1748-9326/9/10/104004

Page, R., & Dilling, L. (2020). How experiences of climate extremes motivate adaptation among water managers. *Climatic Change*, *161*(3), 499–516. https://doi.org/10.1007/s10584-020-02712-7

Palazzo, J., Liu, O. R., Stillinger, T., Song, R., Wang, Y., Hiroyasu, E. H. T., Zenteno, J., Anderson, S., & Tague, C. (2017). Urban responses to restrictive conservation policy during drought. *Water Resources Research*, *53*(5), 4459–4475. https://doi.org/10.1002/2016WR020136

Paneque Salgado, P., & Vargas Molina, J. (2015). Drought, social agents and the construction of discourse in Andalusia. *Environmental Hazards*, *14*(3), 224–235. https://doi.org/10.1080/17477891.2015.1058739

Panu, U. S., & Sharma, T. C. (2002). Challenges in drought research: Some perspectives and future directions. *Hydrological Sciences Journal*, *47*(sup1), S19–S30. https://doi.org/10.1080/02626660209493019

Parry, S., Wilby, R. L., Prudhomme, C., & Wood, P. J. (2016). A systematic assessment of drought termination in the United Kingdom. *Hydrology and Earth System Sciences*, *20*(10), 4265–4281. https://doi.org/10.5194/hess-20-4265-2016

Pischke, F., & Stefanski, R. (2016). Drought management policies – from global collaboration to national action. *Water Policy*, *18*(S2), 228–244. https://doi.org/10.2166/wp.2016.022

Postel, S. (1992). *The last oasis: Facing water scarcity*. Earthscan.

Puy, A., & Lankford, B. (2024). *The Water Crisis by the Global Commission on the Economics of Water: A Totalising Narrative Built on Shaky Numbers*. *17*(2).

QSR International Pty Ltd. (2012). NVivo qualitative data analysis software. *Version 10*.

Raikes, J., Smith, T. F., Jacobson, C., & Baldwin, C. (2019). Pre-disaster planning and preparedness for floods and droughts: A systematic review. *International Journal of Disaster Risk Reduction*, *38*, 101207. https://doi.org/10.1016/j.ijdrr.2019.101207

Reckien, D., Flacke, J., Dawson, R. J., Heidrich, O., Olazabal, M., Foley, A., Hamann, J. J.-P., Orru, H., Salvia, M., De Gregorio Hurtado, S., Geneletti, D., & Pietrapertosa, F. (2014). Climate change response in Europe: What's the reality? Analysis of adaptation and mitigation plans from 200 urban areas in 11 countries. *Climatic Change*, *122*(1), 331–340. https://doi.org/10.1007/s10584-013-0989-8

Rein, M. (1983). Value-Critical Policy Analysis. In D. Callahan & B. Jennings (Eds.), *Ethics, The Social Sciences, and Policy Analysis* (pp. 83–111). Springer US. https://doi.org/10.1007/978-1-4684-7015-4_5

Resilient Cities Network. (2022a, September 16). *Member Cities*. https://resilientcitiesnetwork.org/member-cities/

Resilient Cities Network. (2022b, September 21). *City Water Resilience Approach*. https://resilientcitiesnetwork.org/city-water-resilience-approach/

Richter, B. D., Abell, D., Bacha, E., Brauman, K., Calos, S., Cohn, A., Disla, C., O'Brien, S. F., Hodges, D., Kaiser, S., Loughran, M., Mestre, C., Reardon, M., & Siegfried, E. (2013). Tapped out: How can cities secure their water future? *Water Policy*, *15*(3), 335–363. https://doi.org/10.2166/wp.2013.105

Rihoux, B., & Ragin, C. C. (2009). *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques*. SAGE.

Rijke, J., Smith, J. V., Gersonius, B., van Herk, S., Pathirana, A., Ashley, R., Wong, T., & Zevenbergen, C. (2014). Operationalising resilience to drought: Multi-layered safety for

flooding applied to droughts. *Journal of Hydrology*, *519*, 2652–2659. https://doi.org/10.1016/j.jhydrol.2014.09.031
Roberts, D., Douwes, J., Sutherland, C., & Sim, V. (2020). Durban's 100 Resilient Cities journey: Governing resilience from within. *Environment and Urbanization*, *32*(2), 547–568. https://doi.org/10.1177/0956247820946555
Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., … Foley, J. A. (2009). A safe operating space for humanity. *Nature*, *461*(7263), 472–475. https://doi.org/10.1038/461472a
Román, M. (2010). Governing from the middle: The C40 Cities Leadership Group. *Corporate Governance*, *10*(1), 73–84. https://doi.org/10.1108/14720701011021120
Romero-Lankao, P., & Gnatz, D. M. (2016). Conceptualizing urban water security in an urbanizing world. *Current Opinion in Environmental Sustainability*, *21*, 45–51. https://doi.org/10.1016/j.cosust.2016.11.002
Rossi, G., & Cancelliere, A. (2013). Managing drought risk in water supply systems in Europe: A review. *International Journal of Water Resources Development*, *29*(2), 272–289. https://doi.org/10.1080/07900627.2012.713848
Roy, M., Woodruff, S., Meerow, S., Hannibal, B., Matos, M., & Gilbertson, P. (2024). Quality of Cities' Networks of Plans and Prospects for Flood Resilience. *Journal of Planning Education and Research*, 0739456X241236486. https://doi.org/10.1177/0739456X241236486
Rugland, E. (2021). *Integrating Land and Water: Tools, Practices, Processes, and Evaluation Criteria* (p. 52). Lincoln Institute of Land Policy. https://www.lincolninst.edu/publications/working-papers/integrating-land-water
Runyon, L., & Sackett, H. (2021, May 5). *Colorado Is Examining Water Speculation, And Finding It's 'All The Problems' In One*. KUNC. https://www.kunc.org/environment/2021-05-05/colorado-is-examining-water-speculation-and-finding-its-all-the-problems-in-one
Rushforth, R. R., Messerschmidt, M., & Ruddell, B. L. (2020). A Systems Approach to Municipal Water Portfolio Security: A Case Study of the Phoenix Metropolitan Area. *Water*, *12*(6), Article 6. https://doi.org/10.3390/w12061663
Santha, S. D., & Sasidevan, D. (2018). The Social Construction of Water Scarcity: An Exploration Study along the "Bharathapuzha" in Kerala. *Glocalism*, *3*. https://doi.org/10.12893/gjcpi.2018.3.6
Savelli, E., Mazzoleni, M., Di Baldassarre, G., Cloke, H., & Rusca, M. (2023). Urban water crises driven by elites' unsustainable consumption. *Nature Sustainability*, *6*(8), 929–940. https://doi.org/10.1038/s41893-023-01100-0
Savelli, E., Rusca, M., Cloke, H., & Di Baldassarre, G. (2022). Drought and society: Scientific progress, blind spots, and future prospects. *WIREs Climate Change*, *13*(3), e761. https://doi.org/10.1002/wcc.761
Schewe, J., Heinke, J., Gerten, D., Haddeland, I., Arnell, N. W., Clark, D. B., Dankers, R., Eisner, S., Fekete, B. M., Colón-González, F. J., Gosling, S. N., Kim, H., Liu, X., Masaki, Y., Portmann, F. T., Satoh, Y., Stacke, T., Tang, Q., Wada, Y., … Kabat, P. (2014). Multimodel assessment of water scarcity under climate change. *Proceedings of*

the National Academy of Sciences, *111*(9), 3245–3250. https://doi.org/10.1073/pnas.1222460110

Schmidt, G., Do Ó, A., Markowska, A., Benítez-Sanz, C., Tetelea, C., Cinova, D., Stonevičius, E., Kampa, E., Vroom, I., Fehér, J., Rouillard, J., Väljataga, K., Navas, L., De Stefano, L., Matthew Jones, Dekker, M., Gustafsson, O., Lundberg, P., Pengal, P., … Lukacova, Z. (2023). *Stock-taking analysis and outlook of drought policies, planning and management in EU Member States: Final report*. Directorate-General for Environment (European Commission). https://data.europa.eu/doi/10.2779/21928

Scott, C. A., Flores-López, F., & Gastélum, J. R. (2007). Appropriation of Río San Juan water by Monterrey City, Mexico: Implications for agriculture and basin water sharing. *Paddy and Water Environment*, *5*(4), 253–262. https://doi.org/10.1007/s10333-007-0089-3

Scott, C. A., & Pablos, N. P. (2011). Innovating resource regimes: Water, wastewater, and the institutional dynamics of urban hydraulic reach in northwest Mexico. *Geoforum*, *42*(4), 439–450. https://doi.org/10.1016/j.geoforum.2011.02.003

Simpson, N. P., Shearing, C. D., & Dupont, B. (2020). Gated Adaptation during the Cape Town Drought: Mentalities, Transitions and Pathways to Partial Nodes of Water Security. *Society & Natural Resources*, *33*(8), 1041–1049. https://doi.org/10.1080/08941920.2020.1712756

Singh, C., Jain, G., Sukhwani, V., & Shaw, R. (2021). Losses and damages associated with slow-onset events: Urban drought and water insecurity in Asia. *Current Opinion in Environmental Sustainability*, *50*, 72–86. https://doi.org/10.1016/j.cosust.2021.02.006

Soliman, A. (2022). Prescriptive drought policy and water supplier compliance. *Ecological Economics*, *197*, 107429. https://doi.org/10.1016/j.ecolecon.2022.107429

Sonnett, J., Morehouse, B. J., Finger, T. D., Garfin, G., & Rattray, N. (2006). Drought and declining reservoirs: Comparing media discourse in Arizona and New Mexico, 2002–2004. *Global Environmental Change*, *16*(1), 95–113. https://doi.org/10.1016/j.gloenvcha.2005.11.004

Stolte, T. R., Moel, H. de, Koks, E. E., Wens, M. L. K., Veldhoven, F. van, Garg, S., Farhad, N., & Ward, P. J. (2023). Global drought risk in cities: Present and future urban hotspots. *Environmental Research Communications*, *5*(11), 115008. https://doi.org/10.1088/2515-7620/ad0210

Sullivan, A., Turner, V. K., & White, D. D. (2024). Framing uncertainty in water policy discourse: Insights from Arizona’s Project ADD Water. *Journal of Environmental Studies and Sciences*, *14*(2), 256–268. https://doi.org/10.1007/s13412-023-00868-z

Sullivan, A., & White, D. D. (2020). Climate change as catastrophe or opportunity? Climate change framing and implications for water and climate governance in a drought-prone region. *Journal of Environmental Studies and Sciences*, *10*(1), 1–11. https://doi.org/10.1007/s13412-019-00573-w

Sutherland, C., Roberts, D., & Douwes, J. (2019). Constructing resilience at three scales: The 100 Resilient Cities programme, Durban’s resilience journey and water resilience in the Palmiet Catchment. *Human Geography*, *12*(1), 33–49. https://doi.org/10.1177/194277861901200103

Svarstad, H., Overå, R., & Benjaminsen, T. (2018). Power theories in political ecology. *Journal of Political Ecology*, *25*(1). https://doi.org/10.2458/v25i1.23044

Swyngedouw, E. (1997). Power, Nature, and the City. The Conquest of Water and the Political Ecology of Urbanization in Guayaquil, Ecuador: 1880–1990. *Environment and Planning A: Economy and Space*, *29*(2), 311–332. https://doi.org/10.1068/a290311

Swyngedouw, E., & Williams, J. (2016). From Spain's hydro-deadlock to the desalination fix. *Water International*, *41*(1), 54–73. https://doi.org/10.1080/02508060.2016.1107705

Taylor, Z., Fitzgibbons, J., & Mitchell, C. L. (2021). Finding the future in policy discourse: An analysis of city resilience plans. *Regional Studies*, *55*(5), 831–843. https://doi.org/10.1080/00343404.2020.1760235

Thomann, E., & Maggetti, M. (2020). Designing Research With Qualitative Comparative Analysis (QCA): Approaches, Challenges, and Tools. *Sociological Methods & Research*, *49*(2), 356–386. https://doi.org/10.1177/0049124117729700

Tortajada, C., Kastner, M. J., Buurman, J., & Biswas, A. K. (2017). The California drought: Coping responses and resilience building. *Environmental Science & Policy*, *78*(Supplement C), 97–113. https://doi.org/10.1016/j.envsci.2017.09.012

Tsegai, D., Augenstein, P., & Huang, Z. (2023). *Global Drought Snapshot 2023: The need for proactive action*. United Nations Convention to Combat Desertification. https://www.droughtglobal.org/_files/ugd/648a9d_af549f9432e84673804730e2c0529049.pdf?index=true

UNCCD. (n.d.-a). *Drought planning*. United Nations Convention to Combat Desertification. Retrieved 15 May 2024, from https://www.unccd.int/land-and-life/drought/drought-planning

UNCCD. (n.d.-b). *International Drought Resilience Alliance*. Retrieved 15 May 2024, from https://idralliance.global/

UNCCD. (n.d.-c). *The Drought Initiative*. United Nations Convention to Combat Desertification. Retrieved 15 May 2024, from https://www.unccd.int/land-and-life/drought/drought-initiative

University of Sussex Science Policy Research Unit (with Cole, H. S. D.). (1973). *Thinking about the future: A critique of The limits to growth*. Chatto & Windus for Sussex University Press.

van Hulst, M., & Yanow, D. (2016). From Policy "Frames" to "Framing": Theorizing a More Dynamic, Political Approach. *The American Review of Public Administration*, *46*(1), 92–112. https://doi.org/10.1177/0275074014533142

Van Loon, A. F. (2015). Hydrological drought explained. *WIREs Water*, *2*(4), 359–392. https://doi.org/10.1002/wat2.1085

Van Loon, A. F., Gleeson, T., Clark, J., Van Dijk, A. I. J. M., Stahl, K., Hannaford, J., Di Baldassarre, G., Teuling, A. J., Tallaksen, L. M., Uijlenhoet, R., Hannah, D. M., Sheffield, J., Svoboda, M., Verbeiren, B., Wagener, T., Rangecroft, S., Wanders, N., & Van Lanen, H. A. J. (2016). Drought in the Anthropocene. *Nature Geoscience*, *9*(2), Article 2. https://doi.org/10.1038/ngeo2646

Van Loon, A. F., Stahl, K., Di Baldassarre, G., Clark, J., Rangecroft, S., Wanders, N., Gleeson, T., Van Dijk, A. I. J. M., Tallaksen, L. M., Hannaford, J., Uijlenhoet, R., Teuling, A. J., Hannah, D. M., Sheffield, J., Svoboda, M., Verbeiren, B., Wagener, T., & Van Lanen, H. A. J. (2016). Drought in a human-modified world: Reframing drought definitions, understanding, and analysis approaches. *Hydrology and Earth System Sciences*, *20*(9), 3631–3650. https://doi.org/10.5194/hess-20-3631-2016

Van Loon, A. F., & Van Lanen, H. a. J. (2013). Making the distinction between water scarcity and drought using an observation-modeling framework. *Water Resources Research*, *49*(3), 1483–1502. https://doi.org/10.1002/wrcr.20147

Vasilescu, L., Khan, A., & Himayatullah, K. (2008). Disaster Management Cycle—A Theoretical Approach. *Management & Marketing - Craiova*, *1*, 43–50.

Verbist, K., Amani, A., Mishra, A., & Cisneros, B. J. (2016). Strengthening drought risk management and policy: UNESCO International Hydrological Programme's case studies from Africa and Latin America and the Caribbean. *Water Policy*, *18*(S2), 245–261. https://doi.org/10.2166/wp.2016.223

Vogel, C., & Olivier, D. (2019). Re-imagining the potential of effective drought responses in South Africa. *Regional Environmental Change*, *19*(6), 1561–1570. https://doi.org/10.1007/s10113-018-1389-4

Wickham, E. D., Bathke, D., Abdel-Monem, T., Bernadt, T., Bulling, D., Pytlik-Zillig, L., Stiles, C., & Wall, N. (2019). Conducting a drought-specific THIRA (Threat and Hazard Identification and Risk Assessment): A powerful tool for integrating all-hazard mitigation and drought planning efforts to increase drought mitigation quality. *International Journal of Disaster Risk Reduction*, *39*, 101227. https://doi.org/10.1016/j.ijdrr.2019.101227

Wilhite, D. A. (2016). Managing drought risk in a changing climate. *Climate Research*, *70*(2–3), 99–102. https://doi.org/10.3354/cr01430

Wilhite, D. A., & Glantz, M. H. (1985). Understanding: The Drought Phenomenon: The Role of Definitions. *Water International*, *10*(3), 111–120. https://doi.org/10.1080/02508068508686328

Wilkins, L., & Patterson, P. (1990). Risky business: Covering slow-onset hazards as rapidly developing news. *Political Communication*, *7*(1), 11–23. https://doi.org/10.1080/10584609.1990.9962884

Williams, J. (2022). *Desalination in the 21st Century: A Critical Review of Trends and Debates*. *15*(2).

Williams, J., & Swyngedouw, E. (2018). Mobilising the oceans to quench our thirst. *Tapping the Oceans*, 1–23.

Woodruff, S. C., Meerow, S., Stults, M., & Wilkins, C. (2022). Adaptation to Resilience Planning: Alternative Pathways to Prepare for Climate Change. *Journal of Planning Education and Research*, *42*(1), 64–75. https://doi.org/10.1177/0739456X18801057

Woodruff, S., Meerow, S., Hannibal, B., Matos, M., Roy, M., & Gilbertson, P. (2022). More than the Sum of Their Parts: Approaches to Understand a Network of Plans. *Journal of Planning Education and Research*, 0739456X221096395. https://doi.org/10.1177/0739456X221096395

Zeff, H. B., Herman, J. D., Reed, P. M., & Characklis, G. W. (2016). Cooperative drought adaptation: Integrating infrastructure development, conservation, and water transfers into adaptive policy pathways. *Water Resources Research*, *52*(9), 7327–7346. https://doi.org/10.1002/2016WR018771

Zhang, X., Chen, N., Sheng, H., Ip, C., Yang, L., Chen, Y., Sang, Z., Tadesse, T., Lim, T. P. Y., Rajabifard, A., Bueti, C., Zeng, L., Wardlow, B., Wang, S., Tang, S., Xiong, Z., Li, D., & Niyogi, D. (2019). Urban drought challenge to 2030 sustainable development goals. *Science of The Total Environment*, *693*, 133536. https://doi.org/10.1016/j.scitotenv.2019.07.342

Zweig, G. Z., Mark Pelling, Anton Cartwright, Eric Chu, Tanvi Deshpande, Leila Harris, Keith Hyams, Jean Kaunda, Benjamin Klaus, Kavya Michael, Lorena Pasquini, Robyn Pharoah, Lucy Rodina, Dianne Scott, Patricia. (2017). Inserting rights and justice into urban resilience: A focus on everyday risk - Gina Ziervogel, Mark Pelling, Anton Cartwright, Eric Chu, Tanvi Deshpande, Leila Harris, Keith Hyams, Jean Kaunda, Benjamin Klaus, Kavya Michael, Lorena Pasquini, Robyn Pharoah, Lucy Rodina, Dianne Scott, Patricia Zweig, 2017. *Environment and Urbanization*. https://journals.sagepub.com/doi/full/10.1177/0956247816686905