Big infrastructure and/as systemic flexibility: The Sites Reservoir story

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Abstract

If constructed as planned, the Sites Reservoir Project will add roughly 1.85 billion m^3 (1.5 million acre-feet) of storage capacity to California's water system. Per project proponents, however, the reservoir complex should be understood as infrastructure that would not only increase available water supply but also provide the state's water network with an infusion of a vital systemic quality: flexibility. This article considers such discourses of flexibility through a case study of the Sites project, grounded in analysis of planning documents, government, think tank, and NGO reports, and media coverage from outlets across California. The resulting account shows how the ideal of the flexible system orients efforts to adapt the California water network to the heightened forms of hydrological variability associated with climate change. The analysis traces the emergence of the notion of a "flexibility crisis" plaguing the state's water network and elaborates the temporalities and spatialities characteristic of the systemic flexibility that Sites is understood to enhance. The project of increasing the water network's flexibility through the construction of new large-scale storage infrastructures like Sites is shown to be an undertaking that serves to sustain of many of the system's established (and notably inflexible) consumptive arrangements. The case thus demonstrates the importance of attending to how material properties like flexibility – commonly glossed as desirable system-scale qualities – come to be unevenly spatialized within infrastructural networks and across landscapes.

Key words: drought, political ecology of water, settler colonialism, flexibility, storage, resilience

Résumé

S'il est construit comme prévu, le projet Sites Reservoir ajoutera environ 1,85 milliard de m^3 (1,5 million d'acres-pieds) de capacité de stockage au système d'eau de Californie. Cependant, selon les promoteurs du projet, le complexe de réservoirs doit être compris comme une infrastructure qui non seulement augmenterait l'approvisionnement en eau disponible, mais fournirait également au réseau d'eau de l'État une qualité systémique vitale : la flexibilité. Cet article examine ces discours sur la flexibilité à travers une étude de cas du projet Sites, fondée sur l'analyse de documents de planification, de rapports du gouvernement, de groupes de

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réflexion et d'ONG, ainsi que sur la couverture médiatique des médias de toute la Californie. Le récit qui en résulte montre comment l'idéal du système flexible oriente les efforts visant à adapter le réseau d'eau californien aux formes accrues de variabilité hydrologique associées au changement climatique. L'analyse retrace l'émergence de la notion de « crise de flexibilité » qui frappe le réseau d'eau de l'État et élabore les temporalités et spatialités caractéristiques de la flexibilité systémique que Sites est censé renforcer. Le projet d'augmentation de la flexibilité du réseau d'eau grâce à la construction de nouvelles infrastructures de stockage à grande échelle telles que Sites s'avère être une entreprise qui sert à maintenir de nombreuses dispositions de consommation établies (et particulièrement rigides) du système. Ce cas démontre ainsi l'importance de s'intéresser à la manière dont les propriétés matérielles telles que la flexibilité – généralement considérées comme des qualités souhaitables à l'échelle du système – en viennent à être inégalement spatialisées au sein des réseaux d'infrastructures et à travers les paysages.

Mots-cles: sécheresse, écologie politique de l'eau, colonialisme de peuplement, flexibilité, stockage, résilience

Resumen

Si se construye según lo planeado, el Proyecto de Embalse de Sites agregará aproximadamente 1,850 millones de m^3 (1,5 millones de acres-pies) de capacidad de almacenamiento al sistema de agua de California. Sin embargo, según los proponentes del proyecto, el complejo de embalses debe entenderse como una infraestructura que no solo aumentaría el suministro de agua disponible sino que también proporcionaría a la red de agua del estado una infusión de una cualidad sistémica vital: la flexibilidad. Este artículo considera dichos discursos de flexibilidad a través de un estudio de caso del proyecto Sites, basado en el análisis de documentos de planificación, informes del gobierno, grupos de expertos y ONG, y la cobertura de los medios de comunicación de toda California. El relato resultante muestra cómo el ideal del sistema flexible orienta los esfuerzos para adaptar la red de agua de California a las formas intensificadas de variabilidad hidrológica asociadas con el cambio climático. El análisis rastrea el surgimiento de la noción de una "crisis de flexibilidad" que afecta a la red de agua del estado y elabora las temporalidades y espacialidades características de la flexibilidad sistémica que se entiende que Sites mejora. El proyecto de aumentar la flexibilidad de la red de agua mediante la construcción de nuevas infraestructuras de almacenamiento a gran escala como Sites se muestra como una empresa que sirve para sostener muchos de los acuerdos consuntivos establecidos (y notablemente inflexibles) del sistema. Por lo tanto, el caso demuestra la importancia de prestar atención a cómo las propiedades materiales como la flexibilidad (comúnmente glosadas como cualidades deseables a escala de sistema) llegan a espacializarse de manera desigual dentro de las redes de infraestructura y entre paisajes.

Palabras clave: sequía, ecología política del agua, colonialismo, flexibilidad, almacenamiento, resiliencia.

1. Introduction

In August 2021 Robert Cheng and Charley Wilson, a pair of Southern California-based water managers, penned an op-ed about an unbuilt Northern California reservoir complex for the *Orange County Register*. The authors were effusive about the proposed water storage infrastructure, titling their piece "Sites Reservoir a generational opportunity to tackle California's drought challenge." Their short essay dwells on the straightforward volumetric benefits they believe the project could offer the state's water provision network, arguing that a constructed Sites would hold a valuable new stockpile of liquid that could help California cities and farms sustain operations-as-usual through the long stretches of aridity anticipated to mark the climate-changed decades ahead.[2] But in addition to the recurring specter of future water scarcity in the western half of the United States, a concern less popularly associated with the concrete of dams crept into the piece: flexibility. Describing the Sites project, the authors framed the reservoir as a facility that would offer a vital infusion of this prized quality to California's sprawling water network. As they put it:

[2] Notably, critical literature on water storage arrangements contradicts many such celebratory accounts of the effects of reservoir development, foregrounding manmade lakes' complex imbrication with conditions of water scarcity and social vulnerability in a wide range of contexts (Kellner, 2021).

> This becomes a win-win, helping the environment and creating more *flexibility* for statewide water operations … This is a project we need to advance – it is a generational opportunity to construct a multi-benefit water storage project that helps restore *flexibility*, reliability, and resiliency to our statewide water supply. (Cheng & Wilson, 2021, emphasis added)

Presented in these terms, Sites' potential to reduce the systemic rigidity and associated vulnerability of California's network of water storage and conveyance infrastructure emerges as a central justification for the reservoir's construction. As such, advocating for its development, the authors also articulate an ideal that increasingly structures discussions of the state's water network and its future, that of the flexible system.

As detailed below, Cheng and Wilson echo a wide range of technocratic actors in such characterizations of the Sites project[3] and its anticipated role within California's water provision system.[4] In planning documents, state and federal government, think tank, and NGO reports, and media coverage from outlets across California, the proposed reservoir is frequently discussed as a much-needed source of flexibility for a network of flows that has become precariously inelastic, a condition associated with worrying susceptibility to drought and other systemic stressors. Analyzing these documents to trace the contours of the flexible system presented within them, we ask: what characteristics or capacities does the term flexibility describe within contemporary water networks? How has this quality come to be attributed to centralized water storage facilities like the Sites Reservoir? And what nodes and forms of inflexibility and stasis are sustained through such infrastructural interventions?

Elaborating our answers, we show how discourses of systemic flexibility serve to scope and bound the California water network in a manner that privileges many of the state's established infrastructural and consumptive arrangements. Enhancing the system's flexibility through the construction of new large-scale storage facilities emerges as a means to secure sustained water deliveries from a dam-dominated water network developed over the course of the 20th century. As such, we contend that the discourses of systemic flexibility articulated around centralized infrastructure projects like Sites can serve to foreclose technocratic engagement with the possibility of more radical reconfigurations of such systems. The flexible system ideal can thus be understood as a discursive formation that buttresses the "new era of big infrastructure" taking hold across the waterscapes of the U.S. West and beyond (Perry & Praskievicz, 2017; see also Crow-Miller *et al*., 2017). The forthcoming construction of the long-delayed Sites project – certified by California Governor Gavin Newsom in November 2023 and currently slated for groundbreaking in 2026 after several decades of discussion – could reasonably be viewed as further evidence of the revitalization of such massive supply-side interventions in this region.

Developing this account, we aim to extend political ecological analysis of water and dams through critical engagement with discourses and narratives of flexibility. This is a distinct project from exploring intersections between water management and the rise of post-Fordist regimes of "flexible accumulation" (Harvey, 1989), a well-treated confluence within the political ecology literature (e.g. Bakker, 2002; Swyngedouw, 2004; Swyngedouw, 2005). Our approach proceeds from a recognition that accounts of infrastructural networks' material properties or qualities function as "rich containers for social meanings extending far beyond the object they qualify" (Ulrich, forthcoming; see also Ingold, 2007). Building on anthropologist Katie Ulrich's recent analysis of how the purported flexibility of the Brazilian sugarcane industry structures narratives of its potential futures, here we explore the imaginative and ideological work that presenting a proposed dam project as a source of systemic flexibility entails. In both cases, flexibility is

[3] One indication of many California water professionals' shared perspective on the matter: the paragraph of the op-ed quoted above is reproduced verbatim from a November 2020 essay on the virtues of Sites, written by the Executive Director of the California Farm Water Coalition and posted on the official Sites Project website (Wade, 2020).

[4] Several distinct understandings of the system concept have oriented natural and social science analysis in recent years (e.g. Olson, 2018; Cadenasso *et al*., 2022). Here, discussing California's extensive network of dams, reservoirs, and aqueducts, we primarily use the term in the sense articulated by Stephen Collier and Andrew Lakoff in their delineation of the "vital systems security" paradigm of governance, denoting complex sociotechnical systems "that are vital to the functioning of the economy, the provisioning of metropolitan areas, and the operation of government" (Collier & Lakoff, 2015, p. 33).

articulated as a property essential to the endurance of a threatened system, and functions as a locus of intervention that deflects critical attention from the broader dynamics of settler colonialism and capitalist accumulation within which the systems in question are embedded. Following Ulrich, we suggest that discourses around such properties can thus be understood to bolster highly circumscribed approaches to systemic adaptation. As such, we contend that they warrant more direct engagement in critical accounts of dam development and contestation. Further, the growing prominence of the flexible system ideal demands careful attention to the question of how such a quality – so frequently articulated as an apolitical and desirable system-scale property – gets unevenly spatialized within networks and landscapes. As our account demonstrates, an infusion of flexibility provided by some nodes within a system can serve to sustain characteristic forms of rigidity in others, a deeply political outcome in a deeply uneven waterscape like California's.

Our approach to the concept of flexibility emerged through a more general exploration of discourse around the Sites Reservoir Project and articulations of a "water crisis" in California. Reviewing project planning documents, government and NGO reports, and newspaper articles from sources across the state, preliminary coding revealed the recurrence of flexibility as a trope associated with both its water system in general and the proposed Sites project in particular. To further examine articulations of the notion, we developed a corpus of 63 newspaper articles (including news reports, op-eds, and editorials) published in California media outlets between 1997 and 2022 that address the Sites project and include the term "flexibility" or "flexible," as well as additional gray literature related to the proposed reservoir. Thematic coding (Boyatzis, 1998) was conducted on the assembled documents, and the resulting account is grounded in this analysis. Our interpretations of these materials are informed by the co-authors' respective ethnographic projects, which have involved preliminary fieldwork with interlocutors directly involved in the Sites project (Linville) and long-term fieldwork among Southern California water managers, including those at agencies that stand to receive water from the reservoir (Randle). Here, however, we present an analysis of our corpus of published documents rather than our field-based data, in the interest of systematically exploring the broader discursive terrain within which our interlocutors operate.

The resulting article proceeds through five sections. First, we further situate the notion of flexibility within the political ecology of water and dams, drawing on anthropological engagements with the concept of the flexible system. Next, we detail the rise of the "flexibility crisis" discourse as both a characterization of California's networked water system and a justification for the Sites project. An examination of how the Sites Reservoir has been framed by proponents as a crucial source of systemic flexibility follows. The penultimate section considers the landscapes and uses of water that such accounts serve sustain and assume to remain inflexible thanks to the development of the new reservoir, briefly exploring counter-discourse (and attendant visions for a more dramatically reworked California water system) articulated through Tribal resistance to Sites and similar water storage projects across the region. Finally, the conclusion considers the stakes of approaching complex and increasingly stressed water systems through the lens of flexibility, both analytically and practically.

2. Infrastructural rigidity, systemic flexibility, and the political ecology of water and dams

Within environmental history and political ecology alike, accounts of large-scale water diversion projects often emphasize the radical changes that such infrastructures can bring to both socio-ecological systems and state-society relations (Swyngedouw 2015; White 1996; Wittfogel 1957). The literature has shown that big dams, reservoirs, and aqueducts can not only enable new forms of agricultural, industrial, and urban development, but also help to refigure power relations within and between communities (Hoag, 2022; Hommes, *et al*., 2019; Perramond, 2018). Often glossed as projects that seek to rationalize nature's unruly flows, these infrastructural arrangements frequently serve to produce or widen forms of social difference, concentrating material and political resources in the hands of the institutions tasked with the water's management (Akhter, 2022; Bakker, 2010; Barnes, 2014; Swyngedouw, 2004). In settler colonial contexts like California, they have been shown to function as "colonial beachheads": infrastructures that establish "the conditions for future

dispossession, displacement, and marginalization" of Indigenous communities in the decades following their construction (Curley, 2021, 388).

In addition to analyzing such forms of transformation, many works have emphasized the sorts of stasis or lock-in that often mark these configurations. As Casey Walsh pithily notes, "by their very nature they [infrastructures] are inflexible and generate path dependency" (Walsh, 2009, pp. 37-38). The concluding chapter of Donald Worster's *Rivers of Empire* dwells on this point at some length, borrowing an expression from anthropologist Marvin Harris (1977) and characterizing the western half of the continental United States as a region caught in a "hydraulic trap" (1985, p. 329). This is an assertion grounded in Worster's assessment of the waves of increasingly large-scale water development that reshaped these landscapes over the course of the 19th and 20th centuries, distilling social power in hands of a small cohort of bureaucrats and agricultural land barons in the process. Invoking Harris's notion of a trap, Worster slots the U.S. West of the late 20th century into a class alongside the "ancient water-controlling civilizations of Asia," which he describes as "stagnant," "fearful of change," and marked by a stymieing "inflexibility" (1985, p. 329). Big dams and associated aqueducts, in both contexts, are presented as infrastructures that underpin dangerous forms of systemic and social rigidity. More recent accounts of infrastructural path dependency, while not typically conveyed on such a sweeping register, also emphasize the role of water and energy networks in quietly solidifying established socio-ecological formations – including in contexts where such arrangements are explicitly acknowledged as culturally damaging or ecologically unsustainable (LaDuke & Cowen, 2020; Meilinger & Monstadt, 2022; O'Neill & Boyer, 2023; Turley, 2021).

Concerns about such systemic inelasticity resonate with broader discursive and cultural formations that have accreted around the notion of flexibility since World War II. Tracking the rise of systems theory and thinking across cultural domains in the United States, anthropologist Emily Martin's *Flexible Bodies* (1995) highlights the attendant valorization of flexibility as a quality of people and systems alike. Drawing on examples from realms ranging from computer software to economics to government organizations to feminism, Martin demonstrates how agile, adaptable, nimble institutions and individuals became widely celebrated over the course of the 20th century's final decades. Returning to the anthropological literature, she turns up a notable precursor to this mode of thinking in the influential Gregory Bateson. In an essay titled "Ecology and flexibility in urban civilization," he defines flexibility as "uncommitted potentiality for change" and terms it necessary to realizing a healthy system "or even to get out of the grooves of the fatal destiny in which our civilization is now caught" (Bateson 2000[1972], p. 501, 502). In contrast to Bateson's earnest account of flexibility, Martin's elaboration of the concept foregrounds its entanglement with the late 20th century's emergent neoliberal market forms and critiques the insidious effects of its celebration in many realms (see also Eriksen, 2005; Ong, 1999; Stacey, 1998).

Notably, Martin and other analysts have suggested that across domains, systemic flexibility has come to be understood as a protective quality, a capacity that enables key elements of a system to remain intact despite exposure to external stressors. As anthropologist Stefan Helmreich, in a study of practitioner discourses of computer system soundness in the 1990s, described the dominant approach to these networks: "both flexibility and stability must be maintained at the same time" (Helmreich, 2000, p. 487). Drawing parallels to framings of a nation-state in need of military protection at its borders, Helmreich (2000) details how his interlocutors assumed that computer systems required "flexible defenses" to secure them from increasingly adaptable viruses, narrating this work as guarding bounded systems from unwanted incursions. Such examples suggest a crucial dimension of flexibility as a prized systemic quality: not every element of or site within a system is meant to be made flexible. Those nodes that take on this quality often do so in the service of preserving others (like borders) in unchanged form. Bateson offers a memorable analogy to convey such dynamics, comparing the healthy, flexible system to "an acrobat on a high wire":

> To maintain the ongoing truth of his basic premise ('I am on the wire'), he must be free to move from one position of instability to another, i.e., certain variables such as the position of his arms and the rate of movement of his arms must have great flexibility, which he uses to maintain the stability of other more fundamental and general characteristics. (Bateson, 2000[1972], p. 503)

As this image suggests, flexibility, while often glossed as a systemic quality, should not be assumed as uniformly distributed within a given system. Likewise, a flexible system, while changeable on some registers, also entails an arrangement marked by plenty of stasis. Given this, considering what elements of a system are (implicitly or explicitly) treated as its "fundamental and general characteristics" to be preserved emerges as a way into understanding whose priorities orient the management of such networks.

Recognizing such assumed differentiation within a desirably flexible system raises questions of how this unevenness plays out in spatial terms – especially when the system in question is a networked infrastructural one. In particular: which nodes within the system are tasked with providing systemic flexibility? And which are assumed require protection to secure their stasis? Ironically, given longstanding critiques like Worster's, dams and reservoirs appear to be understood by many water managers as such sources of elasticity within water networks. Joshua Cousins' (2020) elaboration of the notion of infrastructural malleability illustrates how, over time, water planners and engineers can adapt public representations and operations of such large-scale water infrastructures to address emergent political-ecological threats. Developing this concept through an examination of the shifting operational paradigms at Southern California's Morris Dam, Cousins' analysis presents the dam itself as a sort of flexible platform, its divergent uses enabled by its material qualities and realized though the strategic efforts of its operators.

Recent work on reservoir re-operation and the development of multi-purpose reservoirs as climate adaptation techniques provide further evidence of the interest among water managers across the globe in enhancing the range of operational possibilities for water networks via tactical programs of large-scale water storage and release (Benson, 2018; Ehsani *et al*., 2017; De Souza Leão & De Stefano, 2019; Flaminio & Reynard, 2023; Kellner, 2019; Kellner & Brunner, 2021; Turley *et al*., 2022). While this literature does not critically analyze the attendant discourses of flexibility, it illustrates a growing practitioner understanding of dams and reservoirs as potential sources of plasticity elsewhere within water networks – signalling the salience of considering how such associations have emerged and what forms and sites of inflexibility they help to sustain within these systems.

In the pages that follow we consider public discourse around Sites project, framed by proponents as a source of flexibility for the California water system, to explore such dynamics in that sprawling infrastructural network. As the next section, attests, the proposed reservoir was not always presented by advocates as a potential provider of flexibility for this network. An understanding of emergent threats faced by the state's water system was necessary for such a characterization to stick to the project and advance its prospects for development.

3. The California water network and its creeping flexibility crisis

California is well-known for the enormous, networked skein of dams, reservoirs, aqueducts, canals, and pumps that hold and move water within the state. The infrastructural system that conveys and stores these flows has been glossed as the materialization of a settler-colonial state commitment to "move the rain" (Claire & Surprise, 2022) to the parts of the state where it can produce the most profit, watering coastal cities and enormous inland farms and leaving other landscapes and communities to wither, or, in the sites selected for reservoirs, drown (Dallman *et al*., 2013; Middleton, 2018; Middleton-Manning, *et al*., 2018). Such accounts tend to emphasize both water movement and the state's North-South axis, highlighting the transfer of water from higher (wetter) to lower (dryer) latitudes.

But looking closely at the water network reveals other salient dimensions of its spatial and temporal logics. This is an infrastructural system built to manage intra- and interannual hydrologic variability, to keep water deliveries flowing during both typically dry summers and periodic years-long droughts. Reserve storage, enabled by infrastructures that hold water stockpiles in surface reservoirs and managed aquifers, has long played a constitutive role in smoothing these forms of hydrologic variability and facilitating urban and agricultural development (Randle, 2022). Capturing high river flows from spring rains and melting mountain snowpack, the vast majority of California's extensive array of surface reservoirs – nearly 1500 in total (Escriva-Bou *et al*., 2019) – were developed during the 1900s to provide a water buffer for the system's prioritized users. Many

reservoirs were also designed to provide some combination of flood management, river navigability, and hydropower benefits, often creating complex operational challenges for managers of the manmade lakes.

As initially proposed in the middle of the 20th century, the Sites Reservoir Project was presented as just another potential bowl of backup water for the system – and not a particularly compelling one, at that. An early iteration of the concept, known as the Paskenta-Newville Unit and located in a valley about a dozen miles (19km) away from the land targeted by the current project, was studied by state and federal agencies in the 1960s and 1970s (California DWR, 1973; Bureau of Reclamation, 1973). But the idea was set aside due to funding constraints, evaporation concerns, and the understanding that the need for its storage capacity "does not appear to be immediate" (Bureau of Reclamation, 1973, p. 1). While the prospect of building a new reservoir with the space to hold more than a million acre-feet (123 million m^3) of water in reserve for dry times had its charms, water managers of the era didn't see developing additional storage within the system as a pressing priority.

But the idea of storing Sacramento River water in the area wasn't dormant for long, getting revived (and renamed, and moved a few miles) as a proposed project in the 1980s. The rechristened Sites Reservoir Project then gained considerable steam in 1996, when California voters authorized continued funding for the state's Department of Water Resources (DWR) to study the feasibility of new water storage facilities located North of the California Bay-Delta. The momentum continued in 2000, when the state's California Bay-Delta Program's Programmatic Record of Decision (ROD) identified Sites as one of five potential surface water storage facilities warranting further investigation by the state. While many factors drove this reassessment of the urgency of developing expensive surface storage projects within California, a growing consensus around the need for more operational flexibility within the State Water Project (SWP) and Central Valley Project (CVP)[5] is presented as a key driver, a priority articulated throughout the ROD.

The desire for a more flexible water system emerges as a theme in water manager post-mortems of California's punishing 1987-1992 drought. In a 1993 U.S. Army Corps of Engineers report titled "Lessons learned from the California Drought," which draws on interviews with over 100 water professionals across the state, several forms of flexibility are identified as essential for better withstanding future dry spells. Increased regulatory flexibility, particularly the loosening of rules constraining how and when water deliveries could be made through the Central Valley Project system, is cited repeatedly within the report. A desire to smooth the process of water transfers between users is also mentioned several times, framed as a practical way to increase the system's flexibility (USACE, 1993, p. 143, 148, 173). Taken together, these references to the idea of flexibility foreground a desire to ease the movement of water within the network via shifts in operational rules, an emphasis that suggests the problems at hand were understood as largely the result of the location of water within the system, in addition to the overall volume available. In such documents the ideal of a more flexible water network clearly aligns with a more market-driven water system, on a register familiar from political ecology accounts of crises 'in nature' being used to justify neoliberal reforms to strained networks, enabling the resource to flow more easily to those with both urgent needs and the capacity to pay a premium (Bakker, 2005; Edwards, 2013; Kaika, 2003). As such, it is tempting to simply slot such framings into the context of growing water sector austerity and the well-chronicled rollback of federal investment in water infrastructure that marked the U.S. context from the 1970s onward (Perry & Praskievicz, 2017; Reisner, 1993[1986]).

But evidence suggests that the focus on operational flexibility was also driven by a growing sense that California had built a water network based on increasingly irrelevant assumptions about the state's climatic and hydrological conditions – and, as such, that the system required a new management paradigm and additional infrastructural investment. Remarks by DWR Chief Forecaster Gary Hester at 1994's First National Conference

[5] The CVP is a federal water and power management project, overseen by the U.S. Bureau of Reclamation, that provides irrigation water to many agricultural and municipal consumers in California's Central Valley. The SWP is a state water transference project managed by the California DWR that provides water to urban users in the San Francisco Bay area and Southern California, as well agricultural users in the Central Valley. Both are key components within California's broader water system, relied upon by millions over users across the state. They generally follow the North-South spatial logic outlined above, redistributing water to populous or intensively cultivated sections of California with limited local water supplies.

on 'Climate Change and Water Resources Management' make this case in particularly stark terms. Reflecting on the previous decade, a period that included both the wettest two consecutive years on record and a historic six-year drought, Hester acknowledged that while no one could know whether this pattern of hydrologic variability would continue:

> If it does, the additional uncertainty about the magnitude of future extreme events will have a significant impact on the operation of existing facilities. The need for additional flexibility to meet changing conditions is one of the most frequently cited needs for water projects in the West, even without the prospect of climate change or increased climate variability. Increasing demands, decreasing likelihood of new surface-water development, and a greater emphasis on fish and wildlife needs have underscored the need for operational flexibility. Add to that the prospect of greater uncertainty in hydrology, and the need for flexibility becomes even clearer. (Hester, 1994, p. IV-101)

Figure 1: The location of the proposed Sites Reservoir. Reproduced with permission from the California Water Commission.

Explicitly linking climate change and its attendant periods of aridity and deluge (in addition to the state's growing consumptive and environmental demands) to the need for heightened flexibility in the water system, Hester's comments are marked by a sense of urgency. In his eyes, recent events had clearly indicated that the network he oversaw was too rigid to consistently keep users satisfied; the prospect of even more extreme future hydrological disruptions made the pursuit of additional systemic flexibility pressing. Such an orientation helps

to clarify how state water managers' assessment of the "immediate need" for the Sites Reservoir Project might shift between the 1970s and the 1990s: the growing perception of a flexibility crisis within the system, driven by an increasingly volatile hydrological regime, had changed the calculus. In the years since, this assumption has come to mark discourse around, planning for, and even new federal legislation in support of new water storage projects in California (Lund *et al*., 2014) – particularly Sites. In the section that follows, we elaborate the particular material forms of flexibility that this node is understood to provide within this network of flows.

4. Sites as a (contested) source of water system flexibility

In media coverage of and planning documents for the Sites project, flexibility emerges as somewhat slippery. While discussed as an unquestionably desirable characteristic of a water system, and a property with which this proposed reservoir is uniquely equipped to imbue California's water network, at many moments the term seems to simply characterize the general function of large-scale water storage facilities. After all, the allure of most new reservoirs lies in their potential to increase the overall volume of water stored for future use. The special, flexible appeal of Sites, the careful observer of such advocacy and media coverage will find, is presented as largely rooted in a specific temporal and volumetric prospect – that is, the reservoir's capacity to capture the massive volumes of water associated with Northern California's periodic spring floods.

Descriptions of Sites typically emphasize the fact that the reservoir will be filled with water diverted from the Sacramento River during the rainy spring months, when much of the swollen waterway's flow is currently "wasted" out to the sea.[6] The conserved water will then be held in reserve, available to be doled out for urban, agricultural, or environmental uses in the dry months ahead. As summarized in one account:

> The main goal of the project is the notion of increased flexibility in the water system – Sites could store water when it's abundant in the state – winter and spring, when high flows often escape into the ocean. That stored water could then meet whatever need crops up. It could supplement Lake Shasta deliveries to keep its cold water in storage for use later in the summer, when water temperatures rise. It could release water to flush the Delta of salt water when river flows dwindle. (Creasey, 2014)

As this description suggests, Sites's flexibility is often articulated with reference to the multiple functions its reserve water might serve, and how the facility might be operated in coordination with already-existing reservoirs. Such framings tend to highlight the water's potential uses in maintaining environmental flows through the California Bay-Delta, supporting threatened fish populations in the process (e.g. Brown & Bettner, 2013; Hacking, 2003; Kruger, 2001; Zito, 2009). Water managers frequently emphasize the prospect of Sites increasing the volume of stored water available to fish and other riparian and deltaic flora and fauna during drought years, aligning the prospect of greater systemic flexibility with enhanced ecological health of the broader California waterscape.

While generalizable to many existing and proposed reservoir projects, these potential flexibility benefits are described as especially well-realized through Sites due to the project's form and location. As an off-stream reservoir, meaning that it would be filled by a pipeline connected to the Sacramento River rather than by damming[7] the waterway itself, Sites serves no flood control function. In contrast to multi-purpose reservoirs, like Lake Shasta and Lake Oroville, Sites could be filled to the brim during an early spring deluge without spurring concerns about flooding from subsequent storms. In addition, due to Sites' location North of the California Bay-Delta, it could be operated in coordination with Oroville and Shasta, providing another source of dry-season flows for that sensitive estuary environment. In effect, Sites' contribution to water system flexibility is written as a function of its ability to create more options for both capturing and releasing flows within the system. While most of these benefits are attributable to the simple fact that the project would provide

[6] See Cantor (2017) for an excellent critical account of the complex dimensions of 'waste' in California water law.

[7] While the Sites project will not dam the river from which it sources its water, the resulting reservoir will be contained with two large concrete dams and nine smaller saddle dams.

another holding space for water, these locational and operational details are framed as heightening this capacity and mobilized to justify investment in the US$4.5 billion project.

The anticipated impacts of climate change frequently intersect with discussions of the need for Sites and the systemic flexibility it would bolster. Per one op-ed penned by a pair of Sacramento Valley water managers, "climate change – with its specter of higher peak flows and more extreme drought in the future – makes it even more important that we develop this kind of flexibility" (Brown & Bettner, 2013). This argument, repeated in other op-eds, quotes from water managers, and the Bureau of Reclamation's recently completed feasibility study on the project, is effectively a contention that the state's emergent hydrology will be even more variable than its past iterations, demanding additional capacity to capture high flows, hold them in reserve, and distribute them to users (Aanestad, 2007; Bureau of Reclamation, 2021; Meredith, 2019; Sacramento Bee, 2017). A less predictable flow regime is thus assumed to demand a more pliable system for storing and delivering water.

This story of Sites-as-a-source of flexibility has not gone unquestioned, as many have steadily contested the validity of such hopeful, environment-friendly accounts of the proposed reservoir. Critics of the project have long registered skepticism that, if built, the artificial lake would deliver the promised benefits for riparian ecological communities. On the contrary, environmental groups like the Natural Resources Defense Council have argued that the project's planned water extraction from the Sacramento River would harm local salmon populations (Obegi, 2021), a claim supported by a growing body of ecological research (e.g. Iglesias *et al*., 2017; Michel *et al*., 2021). Save California Salmon, a non-profit affiliated with representatives of several Native California Tribes, presented similar concerns in an anti-Sites online petition that has gathered over 50,000 signatures (Bacher, 2022). While recent California-based ecological research suggests that carefully managed reservoir storage can be compatible with the goal of sustaining threatened fish populations (Null *et al*., 2022), such studies highlight a key point frequently elided in water manager celebrations of Sites and the flexibility it might provide. Namely: a reservoir's capacity to provide environmental benefits should not be read as synonymous with a program of operations that will enable the realization of the desired ecological outcomes (see Benson, 2018; Turley, 2021 for further considerations of such operational practices and their politics). Releasing the reservoir's water in a manner oriented towards a different set of priorities – such as continued agricultural production or urban consumption – is also conceivable. While enhancing the water system's operational possibilities via reservoir development could lead to such outcomes, they are not automatically realized by the construction of such infrastructures or even the diversion of the desired waters.

Keeping in mind this ambivalence around supporters' claims that, if constructed, Sites will be operated in a manner that enhances systemic flexibility and associated ecological health, the following section considers forms of stasis and rigidity facilitated within the water network via the reservoir's development. Exploring some of the nodes and consumption practices rendered stable through the project's intended infusions of pliability suggests the more radical approaches to systemic transformation that a focus on enhancing this form of flexibility serves to displace.

5. Sustaining nodes and logics of inflexibility

Advocating for the Sites project, supporters have often made the case for the reservoir in terms that elide the general population of California with agribusiness operations as co-beneficiaries of water system protections provided by the new reservoir. As the *Sacramento Bee*'s editorial board once put it in a glowing endorsement of the proposed water storage complex:

> Sites would provide water managers with flexibility needed to ensure supplies for 40 million residents, plus all the farms and businesses that also require water. That flexibility will become more important as climate change adds to the unpredictability of California's weather patterns. (Sacramento Bee, 2017)

In contrast, Sites skeptics have long maintained that it is essential to consider the location and nature of the water uses that would be ensured by the reservoir in assessments of the project. We push this perspective just a bit further, drawing the quality of flexibility into the critical frame. As detailed above, Sites has

consistently been labeled a crucial source of flexibility for the California water system. However, such large-scale infrastructures sustain notable forms and nodes of rigidity within the system as well – chief among them, the fields of pistachios and pomegranates that cover sprawling expanses of the state's agricultural interior.

The connection between those rows of trees and the quality of systemic flexibility becomes clear upon consideration of the temporalities of water demand that orchards entail. Since the 1970s, growers in California's Central Valley have undertaken a widespread transition from annual crops like alfalfa, cereals, and cotton to perennial tree crops like oranges, pomegranates, almonds, and pistachios (Gebremichael *et al*., 2021; Mall & Herman, 2019). As journalist Mark Arax has extensively chronicled, planted almond acreage more than tripled between 1995 and 2019, jumping from 500,000 to 1.3 million planted acres (202,300-526,000 ha), growth driven by the lure of high global nut prices (Arax, 2019, p. 114). While this transition to tree crops has brought wealth to a few growers, it has done so at a steep cost to these operations' flexibility, due to the stark decline in the level of interannual variability that they can withstand in their water consumption. Fallowing fields during a dry spell is no longer an option, as doing so could kill the trees and squander a grower's long-term investment in the crop.[8] The embrace of orchards can thus be understood as the widespread adoption of an inflexible consumption arrangement that the construction of Sites would help to extend.

Figure 2: The location of the service areas to be served by water stored in the Sites Reservoir. Figure ES-4 in the Sites Reservoir Project's Environmental Impact Statement. Public Domain.

[8] A 2022 *Los Angeles Times* article on the Sites Reservoir directly invoked such fears with images of a bulldozed almond grove located just outside the boardroom of the Tehama-Colusa Canal Authority, a major supporter of the project (Sahagun, 2022). A full 377 acres (153 ha) of trees were killed by the Authority's chairman due to the high cost of water during the ongoing drought – a wasteful, expensive fate that, he suggests, further surface storage could have helped to prevent.

In addition to sustaining such forms of agricultural stasis, Sites would also maintain rigid urban consumption trajectories. For instance, the Metropolitan Water District (MET), a regional water wholesaler that provides water to more than 19 million Southern California residents, has contributed US$30 million to Sites planning operations and stands to gain priority access to about 50,000 new acre-feet (61.7 million m^3) of annual supply from the constructed reservoir (Bland, 2023). Guided by the 1952 Laguna Declaration, which guarantees sufficient supply to meet demands within its service area, MET has played a pivotal role in underwriting growth in suburban development and attendant water consumption across the Southland throughout the decades since that time (Erie, 2006; Zetland, 2009). Shoring up the agency's available supplies, projects like Sites defer the prospect of reckoning with and shifting away such an expansion-oriented paradigm.

Notably, the supply-side approach to systemic flexibility embodied by projects like Sites stands in stark contrast to those pursued by other infrastructural networks. In an attempt to adapt electric grids to the punctuated daily and seasonal rhythms associated with renewable energy production, some utilities have begun to explore special programs and pricing schemes to incentivize consumers to better align their electricity use with off-peak hours – that is, to pursue more flexible consumption arrangements. Geographers studying such initiatives have shown that the capacity to realize the associated cost savings requires "the ability to shift energy use in time and space, or through changes in intensity or vector" (Powells & Fell, 2019, p. 56), a capability that frequently articulates with socio-economic privilege (see also Powells *et al*., 2014; Angel 2022, 2023). As such findings suggest, attempts to enhance systemic flexibility through demand-side approaches can easily exacerbate established forms of social difference if implemented without careful attention to the dynamics of equity and justice. Keeping these limitations in mind (as well as the material differences between water, electricity, and the networks that source and circulate them), such programs are useful in demonstrating that consumption arrangements can also be approached as potential sources of systemic flexibility in large infrastructural systems, signaling the possibility of a far different distribution of stasis and elasticity than the one facilitated by large-scale, supply-side projects like Sites.

Contesting the Sites Reservoir, Native Californians have consistently drawn attention to the more capacious sense of the systemic rigidity that such interventions sustain, particularly their role in reinforcing forms of settler colonial dispossession. Such framings of Sites are aligned with those articulated through Native resistance to a range of proposed dam construction and expansion plans across the region, as well as Tribal advocacy for dam teardowns and river restoration projects (Gosnell & Kelly, 2010; Middleton, 2018; Middleton-Manning, *et al*., 2018; Claire & Surprise, 2022). Rather than approaching the sustained functioning of water transference projects like the CVP or SWP as *a priori* desirable, Tribal activists question the ecological, economic, and legal logics and exclusions that orient such infrastructural assemblages. As Beth Rose Middleton Manning puts it in her extended analysis of Indigenous resistance to hydropower and conservation projects in Northern California: "These projects [the CVP and SWP] come with many consequences. They are only construed as beneficial because the models that enabled them left out key constraints, such as Indigenous rights, human rights, and the health of nonhuman relatives" (Middleton, 2018, p. 180). Foregrounding the needs, priorities, and forms of more-than-human relationality that the state's water system fails to serve, unsettles the account of the water network's "fundamental and general characteristics" (following Bateson). These accounts reorient new, large-scale storage projects like Sites – demanding engagement with the prospect of pursuing systemic change aligned with a different set of priorities. As Pit River Tribe member Morning Star Gali explained her resistance to the Sites reservoir in a press release from the Save California Salmon coalition:

> We have been working to restore flows to help water quality, and to bring salmon back over the dams and back to native lands for salmon survival and Tribal people. California is losing the salmon and our clean water. This is an issue of justice. We already have over a thousand reservoirs, and more water allocated than exists in California. An environmentally destructive private reservoir being built in an area that is important to native people is a step in the wrong direction. (Save California Salmon, 2021)

Framed in such terms, constructing yet another reservoir looks like nothing so much as a choice to double down on a rigid, damaging approach to water management that has long guided California's water network. From this vantage, enhanced systemic flexibility, understood as a quality that enables the network's protection and continued functioning-as-usual seems a nonsensical priority, given that system's impacts on Tribal people, salmon, and water quality. Such critiques highlight the narrow horizons of systemic change charted by the flexible system ideal that Sites is presented as furthering. Further, they suggest the more capacious scope and scale of water system transformation that could guide the enormous investment of public resources embodied in such infrastructures– were the goals of these interventions not so tightly lashed to the project of protecting the established network from disruption.

6. Conclusion

At the time of this writing, it looks increasingly likely that the Sites Reservoir Project will soon move from planning documents to a more material form, particularly after Newsom's late-2023 greenlighting of the project for construction. Around the time of that approval, the Sites Project Authority reported that US$4.5 billion in funding for the project had been "pretty much" lined up and that they anticipate a 2026 groundbreaking (Plachta, 2023). While new roadblocks are always possible, such key indicators suggest that the largest new California reservoir in 50 years will very likely be built in the years ahead.

As detailed above, over the past three decades of the fight to fund and build Sites, proponents have framed the project as a reservoir that would not only expand the state's water storage capacity, but also provide a key infusion of systemic flexibility into California's water network. The allure of this capacity is grounded in water managers' understandings of insufficient flexibility as a problem plaguing the system, a condition produced through a combination of regulations constraining water transfers between users, high demand across the system, and an increasingly variable precipitation regime. Accordingly, in discourse around Sites, flexibility has been a quality articulated in terms of the additional volume of water that the reservoir would hold for distribution within the system, as well as the strategic location of that reserve water within the network.

Developed at a higher latitude than most of the state's biggest water consumers, the project's capacity to capture large volumes of seasonal runoff during wet years (without the need to grapple with flood-management logistics) and to release it for a wide range of users during the dry season, emerge as the characteristics that define its flexible nature. But in enhancing the water network's flexibility on this register, we have argued, Sites would also enable the maintenance characteristic forms of inflexibility within the network – namely, rigid agricultural and urban consumption patterns. In the process, it would function to secure a system that enacts what Native Californians have termed profound cultural and ecological damage on landscapes across the state. These findings signal the value of considering how, exactly, the quality of flexibility is spatialized within a network, particularly when it is presented as a prized systemic property. As our analysis demonstrates, an uncritical focus on attaining a flexible infrastructural system can serve to obscure the dynamics of stasis inherent to centralized infrastructural interventions. Here, we suggest, the flexible water system is an ideal with substantive stakes for flows of liquid and power relations within California, helping to justify large-scale investments in new expanses of concrete and pipelines that reinforce established arrangements of water control and consumption.

Beyond providing new analytical traction on the dynamics of infrastructure development here and elsewhere, the case study also suggests a potential avenue to extend the growing critical social science literature on resilience. In the effusive Sites op-ed with which we opened this account, the authors characterize Sites as restoring "flexibility, reliability, and resiliency" to California's water network. As such formulations suggest, in this context, achieving systemic flexibility can be viewed as a project imbricated in that of attaining resiliency. Such connections echo Michael Watts' account of the constitutive relationship between these categories within political ecology and related scholarship:

> Irrespective of its specific referent object (drought, youth, finance), the defining quality of virtually all resilience and adaptive thinking, at least in the social and socio-ecological sciences, is a robust relationship to system durability, flexibility, and to a culture of preparedness, preemption, and precaution. (Watts, 2015, p. 40)

In other words, it has come to be widely understood that a resilient system is necessarily a flexible system, an assumption considered so self-evident that it rarely warrants much comment, by practitioners or scholars. Like Watts, we discern a clear resonance between the account of flexibility that we have presented in these pages and the growing body of critical social science literature on resilience, which has revealed similar dynamics of stasis and transformation in discourses around that increasingly prized systemic characteristic (e.g. Davoudi, 2012; Davoudi *et al*., 2013; Evans & Reid, 2014; Wakefield, 2020; Walker & Cooper, 2011). Acknowledging such alignment suggests the value of exploring how the relationship between these two qualities gets articulated and pursued across domains. Further, given their increasingly prominent role in orienting programs of big infrastructure development, untangling such concepts and discourses has the potential offer new critical and discursive tools for those contesting such projects and advocating for infrastructural arrangements otherwise.

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