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Geographies of storage

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Abstract: Resource storage has long played a key role in the production of socio-ecological arrangements and economic relations. Even so, storage as a concept has remained somewhat marginal within geographical scholarship, often obscured by an analytical focus on the dynamics of movement. Reviewing recent works from geography, science and technology studies, and anthropology that center sites and practices of storage, this essay elaborates the diverse ways in which storage arrangements mediate resource circulation and the production of space. This literature demonstrates that thinking systematically with storage can illuminate a range of novel temporal, material, and value entanglements in-the-making, pointing to potentially fruitful avenues for future research.

Keywords: global warming, natural resources, political economy, resources, sustainability, transport

1 INTRODUCTION

In January 2023, the Toronto-based energy storage company Hydrostor announced that it had signed a 200-megawatt (MW) energy storage power purchase agreement Central Coast Community Energy (CCCE), a non-profit electricity supplier serving more than 430,000 California customers (Colthorpe, 2023). Entering this agreement with Hydrostor, CCCE was committing to buy electricity storage capacity from the Canadian company's yet-to-be built 500 MW Willow Rock Energy Storage Center. If constructed as proposed, that advanced compressed air energy storage facility will rely on a custom-made subterranean cavern to pressurize air, which will be used to spin turbines and produce electricity on-demand (Cox, 2022).1 Funded in part by a $250 million investment from Goldman Sachs (Colthorpe, 2022), the Hydrostor facility is slated for development in a remote desert section of California's Kern County—one of several utility-scale energy storage projects currently under consideration across the U.S. West (Turley et al., 2022).

Though unbuilt at the time of this writing, the Willow Rock facility offers a useful entry point for a consideration of the shifting geographies of resource storage in the process of shaping landscapes, infrastructural networks, and flows of capital across the globe. On some level, this is nothing new: material storage and strategic stockpiles have long played a substantive role in the production of socio-ecological arrangements and economic relations (Polanyi, 1944; Marx, 1978(1885)). For instance, holding reserve water behind dams and maintaining large-scale grain stockpiles have underpinned projects of political control and statecraft for centuries (Mann, 1986; Wittfogel, 1957; Worster, 1985). And while accounts of commodities tend to center moments of production, consumption, and (sometimes) transport, storage arrangements are also essential to their circulation (Banoub & Martin, 2020; Orenstein, 2019). At a more intimate scale, domestic resource storage practices mediate both daily rhythms and social hierarchies (Hendon, 2000; Newell, 2018; O'Leary, 2019; White-Nockleby, 2022). We might say that storage arrangements have a broadly infrastructural character (cf Kasper & Schramm, 2023), underpinning flows of resources, capital, and power.

Even so, storage as a concept has remained somewhat marginal within geographical scholarship, left largely untheorized. As several scholars have recently observed, moments of resource confinement have often been obscured by an analytical focus on the dynamics of movement and circulation within infrastructural networks and commodity chains (Banoub & Martin, 2020; Furlong, 2022; Simpson, 2019). A survey of recent literature, however, suggests that a shift is under way within the empirical literature. Both within and beyond geography, emergent arrangements of carbon, energy, water, waste, cryogenic, commodity, and data storage are drawing intense scholarly attention (Amoore, 2018; Bayona-Valderrama et al., 2021; Bell & Macfarlane, 2022; Bridge & Faigen, 2022; Graeter, 2020; Hoag, 2022; Hogan, 2015; Ialenti, 2020; Kon Kam King et al., 2018; Lemke, 2021; Malm & Carton, 2021; Randle, 2022; Simpson, 2019; Turley et al., 2022; White-Nockleby, 2022; Wolff, 2021). This efflorescence has been accompanied by renewed interest in established and historical configurations of

commodity and critical resource storage (Banoub & Martin, 2020; Cousins, 2020; Folkers, 2019; Orenstein, 2019). Read together, such accounts suggest that geographers may find a storage lens is increasingly useful because many such arrangements are in the process of being rapidly expanded or refigured, shifts with potentially sweeping socio-ecological ramifications. Further, recent works demonstrate that thinking systematically with storage can illuminate a range of novel temporal, material, and value entanglements in-the-making, pointing to potentially fruitful avenues for future research on the shifting logics of capital and their attendant spatial formations and political stakes.

Reviewing recent works from geography, science and technology studies, and anthropology that center sites and practices of resource storage, this essay elaborates the diverse ways in which storage arrangements mediate material circulation and the production of space.2 This approach is directly inspired by Daniel Banoub and Sarah Martin's (2020) careful consideration of grain and saltfish storage in late 19th and early 20th century North America, an account that elaborates such arrangements as a contingent form of value production. In particular, I build on their conceptualization of storage sites as lively infrastructural ecologies, "a produced and unruly second nature in the capitalist built environment, central to both value determination and devaluation" (Banoub & Martin, 2020, p. 1106). Framing spaces of storage as more-than-human assemblages deeply imbricated in the process of accumulation, the notion of infrastructural ecologies helpfully orients analysis toward the dynamism of storage sites. It also signals the variable relationship between moments of storage and the production of value, highlighting the investments of capital and labor that storage arrangements can entail—and the fact that, despite such outlays, decaying grain can sometimes cause its storage silos to explode (Banoub & Martin, 2020, p. 1102). These connections in mind, the complex relationships between storage, liveliness, and capitalist value are foregrounded throughout the review.

The analysis proceeds through four sections. In the first, I briefly outline the range of terminology used to characterize storage arrangements, considering the different valences associated with the words storage, stockpiling, containment, confinement, and warehousing across the extant literature. Next, I examine how the relationship between moments of resource stillness and circulation surface within the literature, emphasizing their varied configurations. The third section explores storage's imbrication within the production of landscapes and socio-ecological arrangements, foregrounding its diffuse spatial impacts. The brief conclusion suggests avenues for future research toward developing a storage analytic adequate to the proliferation of novel configurations of storage emerging to address (and profit from) global climate change.

2 STORAGE TERMINOLOGIES AND VARIANTS

Storage, as Caroline White-Nockleby aptly notes, "is not singular" (2022, p. 691). The Oxford English Dictionary's compound definition of the word signals a key aspect of this multiplicity, gesturing toward storage's dual status as both a noun ("capacity or space for storing") and a verb ("the action of storing or laying up in reserve"). Invoked to reference the sites where materials are held and also the practice of holding material in place, storage thus articulates with a wide range of spatial and temporal processes and orientations. Examining categories of storage that have emerged within the scholarly literature helps to clarify some of the distinct registers of stasis, futurity, and relationality associated with some of these arrangements.

The term stockpiling is used to signal a form of storage marked by a distinct sort of temporality: "not about retaining what has happened but about looking forward to what might happen" (Folkers, 2019, p. 495). More concretely, the practice of stockpiling invariably is associated with an anticipated moment of using the stored resources, rather than simply preserving material as a sort of record or archive, or managing its permanent disposal (Elbe et al., 2014; Keck, 2017; Keck, 2020).3 Noting that the term only came into common usage during the United States' strategic preparations for World War II, Andrew Lakoff suggests that "modern stockpiling" is best understood as distinct from past practices, grounded in an understanding of collective life as defined by its "vulnerability to disruptive shock" (2020, p. 1078). Other scholars explicitly connect the concept of the stockpile to Martin Heidegger's (1977) notion of the standing reserve, in which material is transformed into a repository of resources ready-at-hand through a process that he terms "enframing" (Folkers, 2019, pp. 495–496; Lemke, 2021, pp. 7–10). While Heidegger's concept refers to a general disposition rather than any specific stockpile, some have

suggested that actual practices of stockpiling can be productively read as instantiations of this broader approach the material world.

In contrast, the notion of warehousing, as developed in Dara Orenstein's Out of Stock (2019), is more oriented toward processes of commodity circulation and capital accumulation than an assumed moment of using the stored material. Orenstein builds on Karl Marx's account of storage as outlined in the second volume of Capital (1978(1885)), in which he suggests that the distinctive characteristic of capitalist storage is that it seeks to sustain exchange, rather than to support forms of direct use and consumption associated with other modes of production (1978(1885): 218).4 In his formulation, storage also entails a "circulation cost"—that is, an unavoidable deduction from surplus-value production (Marx, 1978(1885); see also Banoub & Martin, 2020; Arboleda & Purcell, 2021). Tracking the rise of the U.S. warehousing industry from the 19th century onward, Orenstein foregrounds these costs (and the situated actors profiting from them), showing how storage space and labor emerged as commodities themselves within growing commodity chains from the 19th century onward. As a 1925 treatise on warehousing put it: "'warehousing' is storing for the purpose of commercial gain" (Haring, 1925, p. 4 in Orenstein, 2019, p. 35). Such accounts signal the analytical value in developing genealogies of the divergent, historically rooted forms that such waystations for commodities-on-the-move can take, and for attending carefully to the distinct roles that such arrangements can play in strategies of accumulation. As the emergence of the sprawling "distribution centers" (the updated term for warehouses—see Cowen, 2014, p. 111) that underpin so much of contemporary commodity circulation attests, storage-as-a-commodity is an evolving configuration.

While discussions of stockpiling and warehousing often dwell on temporal aspects of storage (particularly their relationship to moments of consumption or circulation), explorations of containment frequently focus on the forms of boundedness and relationality that mark such arrangements. The condition of separation enabled through objects and practices of containment is often glossed as their defining characteristic, as in accounts that frame containers as "any object that can hold something else inside itself for an indefinite period of time, isolating the contents from the give and take of the world outside" (Shryock & Smail, 2018, p. 1; see also Robb, 2018). To demonstrate the ubiquity and necessity of such separations within daily life, in an influential essay titled "Container Technologies" (Sofia, 2000), Zoe Sofia offers an extended catalog of domestic instruments of containment, including sauce bottles and envelopes. While the keeping-apart function of containers is readily apparent from such examples, Sofia draws on Lewis Mumford's (1962(1934)) history of technology to argue for a more complex, dynamic view of containers that emphasizes the relations and spatial forms produced through containment. Articulations of containment and containers that build on Sofia's insights reveal these to be categories that sprawl, both across space and into more abstract realms (Duffy & Packer, 2022; Kenner et al., 2019; Schüll, 2018). For instance, practices and technologies of predator fencing (Hawkins & Paxton, 2019) and salmon aquaculture (Schoot & Mather, 2022) have been analyzed as forms of containment, connected by the notion that such arrangements not only hold matter inside but also produce new natures.

Unlike the other terms discussed above, confinement is not frequently deployed as a synonym for storage. Rather, within popular discourse and the carceral geographies literature alike, the term is typically invoked to signal the racialized practices of restricting human movements, particularly through incarceration (Asoni, 2022; Gilmore, 2007; Martin & Mitchelson, 2009; Peters & Turner, 2017). As Orenstein notes in her account of the warehousing industry, the unspoken assumption of such categorical separation becomes evident when abolitionist critics characterize mass incarceration as an unconscionable form of "human warehousing" (Orenstein, 2019, p. 34; see also Herivel & Wright, 2003). Kathryn Furlong's (2022) recent articulation of "infrastructures of confinement" as a category that encompasses material sites constricting the movement of humans and resources alike, however, suggests the generative potential of exploring relationships between such forms of planned immobility in future scholarship.

The sections that follow draw primarily on case studies organized around a wide range of resource storage configurations. Some could be termed stockpiles or instances of warehousing, and many entail arrangements of containment. Considering them together, I sketch how storage arrangements figure in processes of resource circulation and the production of space.

3 STORAGE AND CIRCULATION

For centuries, the capitalist warehouse has been likened to a water reservoir, an analogy deployed to signal its role in sustaining the smooth circulation of materials (Orenstein, 2019, pp. 28–31; see also Marx, 1968[1863]: 870–875). As New York City's growing network of reservoirs held water in reserve to enable the resource's steady trickle to urban consumers (Gandy, 2002), its warehouses held goods still for an interval before sending them onward for purchase, an intended moment of interrupted motion sustaining the generalized flow of materials. In such arrangements, a spatially static storage node clearly underpins expected patterns of movement. As scholars have demonstrated, however, such configurations of stasis and motion are far from a universal template for the relationship between sites of storage and processes of circulation. In practice, the status of spatial fixity in relation to storage arrangements is revealed to be surprisingly slippery—and likewise, its relationship to processes of capital accumulation.

For one, as scholarship on containers and containment demonstrates, many storage vessels themselves are meant to move. Grain sacks, wine bottles, railroad cars, and shipping containers, to name just a few prominent examples from the literature, all unquestionably confine materials intended to exit their containers at some future point. And those holding containers often travel widely, complicating efforts to categorically distinguish storage from circulation (see Cronon, 1991; Martin, 2013; Bevan, 2014; Krüger, 2023 for elaborations of distinct configurations). Characterizations of container ships as "floating warehouses" (Sekula, 2000) and bonded railcars as "warehouses on wheels" (Orenstein, 2018) further illustrate this sort of overlap and the reality that storage is frequently "routed rather than rooted" (Hirsch, 2013, p. 18 in Gregson et al., 2017, p. 385). Acknowledging such forms of storage-in-motion suggests a potential amendment to the "infrastructural ecologies" lens proposed by Banoub and Martin (2020): the conceptualization of mobile containers themselves as constitutive elements of the broader more-than-human storage assemblage.5

Considering spatially fixed storage sites is useful for clarifying the persistent forms of stillness that mark contemporary commodity chains. In many cases, these nodes continue to resemble reservoirs—albeit, increasingly complex, dynamic, and expensively infrastructured ones. While foregrounding the recent acceleration of goods circulating through global supply chains, critical logistical geographies scholarship has been careful to acknowledge the forms of friction, slowness, and immobility that mark these arrangements (Chua et al., 2018; Cowen, 2014; Danyluk, 2021). Attending closely to cargo reveals that, for all the talk of speed, motion, and just-in-time production associated with the logistics industry, moments of storage remain crucial to processes of circulation:

> These planned interruptions are not frictions to be overcome by better tailored algorithms and tighter control but a means to exploit the inherent frictions in the system of flow; they are not the obstacle but rather the means to the space-time coordination of freight cargo and thus to the integration of the global factory and the global warehouse. (Gregson et al., 2017, p. 384)

Given the necessity of such pauses, holding facilities within and beyond ports—including distribution centers, port stacks, and assembly yards—remain constitutive of global flows, albeit increasingly ordered by a "logic of throughput" (Danyluk, 2018, p. 638). Recognizing that the moments of stasis enabled by these nodes are the subject of painstaking planning, coordination, and investment clarifies their status as key sites of potential cost or profit for different actors within the supply chain. As with the warehouses and novel cold storage facilities of centuries past (Freidberg, 2010), owning such facilities can be a lucrative strategy of accumulation, albeit one reliant of sizable investments of fixed capital (Arboleda & Purcell, 2021). As such, accounts of the rise of novel storage infrastructures within established supply chains—such as the massive dome-shaped silos developed to safely hold wood pellets intended for shipping, recently analyzed by Stephen Ramos (2021)—offer a window into both the shifting materialities of and the infrastructural monies embedded within contemporary supply chains.

Sites of storage are also essential to circulatory disruptions that fit awkwardly with the reservoir analogy: the intentional removal of commodities from motion "in the service of capital accumulation" (Simpson, 2019, p. 119, italics original). Elaborating his account of oil producers and speculators holding crude in tank farms, tanker ships, and railcars to keep it from the market during periods of low valuation, Michael Simpson (2019) terms this form of strategic storage the "annihilation of time by space" and suggests that it illustrates the divergent temporal

logics that mark contemporary circulation. Detailing the rising value of storage space itself under such conditions, Simpson's case also helps to illustrate how holding facilities can emerge as not only sites of profit but also of speculation, under certain conditions. Complicating narratives in which speedy circulation is straightforwardly associated with maximum capital accumulation, such accounts signal storage's key mediating role in certain forms of value production—and the compelling possibilities of future research exploring the distinct dynamics across resources and industries (see also Birch & Ward, 2022; Matthan, 2022). As Suzanne Freidberg's studies of the emergence of cold storage in the early 20th century attest, such work can help to illuminate the moral economic dimensions of emergent storage arrangements (Freidberg, 2008, 2010, 2015).

In contrast to storage within commodity chains, stockpiling practices are oriented toward sustaining the movement of and generalized access to crucial resources under anticipated conditions of crisis or scarcity (Elbe et al., 2014; Folkers, 2019). State-managed stockpiles offer perhaps the most prominent examples of this approach, maintaining strategic reserves to buffer against shocks to the "vital systems" that underpin quotidian forms of consumption (Collier & Lakoff, 2015, 2021; Whitington, 2016). But the presence of a stockpile cannot be assumed sufficient to guaranteeing a critical resource's capacity to circulate, as starkly demonstrated throughout the COVID-19 pandemic. Networked infrastructures often mediate such flows, their gaps and omissions limiting the reach of such centralized efforts—highlighting the importance of thinking with both resource circulation and storage beyond grids (Furlong & Kooy, 2017; Kasper & Schramm, 2023).

While such centralized forms of stockpiling are often established with an eye to sustaining resource movement for a broadly conceived public, more intimately scaled arrangements entail a different orientation toward such an imagined collective. Recent analyses of domestic-scale electricity storage in lithium-ion battery arrays (Nucho, 2022; White-Nockleby, 2022) and so-called prepper or survivalist practices (Barker, 2019; Katz-Rosen & Szwarc, 2022: 695) emphasize the atrophied state capacity that guides many such individual approaches to critical resource storage. Such accounts also highlight a distinct sense of futurity that marks these projects of domestic stockpiling: the assumption of ongoing crisis and inevitable circulatory interruption. White-Nockleby's assertion that domestic-scale solar-panel-and-lithium-ion storage assemblages "operate at multiple registers, alleviating future uncertainty as much symbolically as materially" (White-Nockleby, 2022, p. 695; see also Lakoff, 2007) helpfully foregrounds the social functions of such arrangements.

Notably, some forms of storage are not premised on future use or motion—in fact, quite the opposite. Storage-as-disposal is typically premised on the long-term or permanent removal of noxious material from circulation. Carbon capture and sequestration projects, for instance, proceed from an assumption that such interventions can permanently extract CO2 from the atmosphere by storing it in biomass, soil, or other subterranean arrangements (Gifford, 2020; Hansson et al., 2022; Kon Kam King et al., 2018; Osborne, 2013). And while some retain hope that technological innovation will eventually mean that all forms of spent nuclear fuel will be reusable, current work toward deep geological storage of these materials is guided by the assumption of permanent, perfect containment (Foley, 2021; Ialenti, 2020). In the case of both captured carbon and nuclear waste, the plausibility of such indefinite containment remains contested (Granjou & Salazar, 2019; Pitkanen, 2020). The prospect of fire freeing the carbon embodied in trees and undergrowth (not to mention built structures), for instance, looms large in critiques of such "nature"-based sequestration projects (Reardon-Smith, 2023). Nonetheless, these serve as useful examples of how the strategic cultivation of land, and, increasingly, the underground, is now widely approached as a project with the capacity to resolve problems associated with excessive or polluting forms of circulation (Chailleux, 2020; Evans et al., 2009; Gormally et al., 2018; Kearnes & Rickards, 2017).

In the case of carbon dioxide, such projects clearly represent an emergent spatial form of storage-as-accumulation-strategy, leading to calls to "seize the means of carbon removal" from the fossil fuel interests leading many such projects (Malm & Carton, 2021). There is perhaps no starker illustration of this deep entanglement than the fact that most contemporary practices of geological carbon dioxide also support enhanced subterranean oil recovery (Chailleux, 2020; Hansson et al., 2022). Extracting more carboniferous material while holding its unwanted waste products in place, such projects signal the potential for these long-term storage arrangements to function as key socio-ecological fixes, facilitating the extension of the arrangements of (fossil) capitalist circulation and accumulation writ large in the process (Castree & Christophers, 2015; Ekers & Prudham, 2015). Storage via such forms of sequestration thus figure not as a reservoir, but as Andreas Malm and Wim Carton memorably put it, as "a subsurface sewage system" (2021, p. 11).

4 STORAGE AND THE PRODUCTION OF SPACE

Storage assemblages order landscapes, often in ways that preclude many potential uses of the space. Reservoirs are an obvious example of this tendency, inundating land for the sake of perpetual water storage, often at the expense of established settlements and Indigenous communities' sacred sites (Cantor et al., 2023; Middleton Manning, 2018; Vickers, 2022). But the spatial impacts of storage sites often extend well beyond such facilities' boundaries, as signaled by their characterization as infrastructural ecologies (Banoub & Martin, 2020). In the case of reservoirs, the inundation often creates the necessary conditions of possibility to rationalize the surrounding landscapes for profit-driven development (Claire & Surprise, 2022). Likewise, large-scale distribution centers have been shown to not only rework the local landscapes adjacent to the warehouses themselves, but also to exacerbate local environmental degradation along associated trucking corridors (De Lara, 2018a; De Lara, 2018b). Subterranean resource holding facilities, like the proposed Willow Rock Energy Storage Center discussed at this essay's outset, are also often seen as broader ecological threats, garnering formal complaints from conservation groups for their potential to degrade the habitats of threatened species (Roth, 2023).

Further, storage sites can reshape terrain through their metabolism of energy and resources necessary to the support of their containment functions. For instance, a growing archipelago of data storage facilities requires sizable, sustained inputs of water and electricity to function, sometimes straining local waterscapes and electric grids (Amoore, 2018; Bresnihan & Brodie, 2021; Bresnihan & Brodie, 2023; Furlong, 2021; Hogan, 2015). On a similar register, recent research emphasizes storage's sprawling footprint through a review of renewable energy storage development in the U.S. West, detailing how desert arrays of lithium-ion batteries rework socio-ecologies in both the landscapes where they are sited and the lithium-rich regions that supply the essential element of the batteries (Turley et al., 2022). As the growing green extractivism literature demonstrates, these “clean” forms of energy storage are frequently mobilized to justify locally devastating mining operations (Hernandez & Newell, 2022; Jerez et al., 2021; Voskoboynik & Andreucci, 2022). Such examples highlight the fact that storage arrangements are themselves enabled by supply chains, and assessments of storage's spatial impacts should account for those connections. Further, as Gavin Bridge and Erika Faigen (2022) show in a recent account of lithium-ion battery assemblages, situating energy storage supply chains within a global production network reveals an even broader infrastructural and institutional ecology within which these nodes are embedded.

Considering storage sites' imbrication within a broad suite of flows and processes (both local and extra-local) also draws attention to the porous nature of such facilities. While developed to contain and preserve certain materials, these assemblages are typically marked by various forms of leakage, seepage, and permeability. Beyond the sorts of intentional resource inputs noted above, storage sites can also take in less desired elements of the local environment. Heat and moisture, for instance, can quickly degrade stored materials if not studiously managed via a combination of supportive infrastructure and sustained labor—realities made particularly stark in accounts of seed storage facilities (Lemke, 2021; Wolff, 2021). The well-documented role of water storage sites (particularly small, distributed ones) in mosquito breeding point to how other creatures can make use of such infrastructures for their own purposes, transforming the stored resource into “water with larvae” (Acevedo-Guerrero, 2022: see also Kelly & Lezaun, 2014; Bayona-Valderrama et al., 2021). These risks are perhaps most pronounced in cases of nuclear and toxic waste storage, where permeable facilities lead to the accumulation of carcinogenic materials within the local environment and human bodies themselves (Brown, 2016; Graeter, 2020). Such examples signal the importance of approaching containment as a convenient fiction or a tenuous achievement, given the possibilities for transformation of both stored materials and local environments (and their inhabitants) via seepage (Cons, 2020). Scholars of the nuclear industry have drawn attention to containment as a broader logic with roots in the Cold War geopolitics commonly associated with the term, highlighting the discursive and institutional practices within which material arrangements of containment are embedded (Petryna, 2002; Masco, 2006; Pitkanen, 2020; see also Ahmann & Kenner, 2020)—further signaling the value of considering who, exactly, benefits (through direct profit or otherwise) from framings of waste storage sites as cleanly bounded entities.

As noted above, managing diverse forms of encroachment and decay around storage sites often requires not only infrastructure but also ongoing human labor. Anthropologists have led the way in examining the materiality of these forms of work, signaling the value of ethnographic methods to such analysis (Hoag, 2022; Johnson, 2019; Kurtic, 2023). For instance, the spatial and social stakes of such storage labor are central objects of analysis in Colin Hoag's ethnography of Lesotho's emergence as a “water reservoir” for urban South Africa (2022, p. 9). As

he details, sediment flows threaten the grand Lesotho Highland Water Project, an extensive array of water storage reservoirs and pipelines developed to serve water-stressed Johannesburg across the border, highlighting the importance of storage as a geopolitical arrangement in some contexts (see also Folch, 2019; Hayat, 2022). In response, the state has developed a mix of public works and social engineering projects directed toward curtailing erosion—but that, in practice, tend to function more effectively at redistributing state resources than holding soil still. Joshua Cousins' (2020) account of water managers' shifting uses and representations of Southern California's Morris Dam highlights a complementary insight: that storage assemblages often serve multiple functions of the course of their lives, requiring novel public narratives for their justification. As such examples suggest, producing and maintaining storage arrangements often depends on diverse forms of discursive, bureaucratic, and material labor. The ascendance of terrestrial carbon storage initiatives referenced above points to the growing urgency of examining the many forms of labor that such storage via infrastructural nature (Nelson & Bigger, 2022) demands, particularly the relationship between these forms of human work and capitalist valuation.

5 CONCLUSION

As the works reviewed here demonstrate, sites and arrangements of resource storage shape material circulations and landscapes alike. Approached as infrastructural ecologies, they emerge as lively, porous sites often sustained by complex infrastructures and ongoing inputs of human labor. Such insights suggest the value of future considerations of storage's structuring role in processes of spatial production and capital accumulation across a diverse range of landscapes, and the potential for a storage lens to reveal entanglements and relations typically obscured in analyses more focused on flows, circulations, and movement. Further, this body of work shows that storage—in both its noun and verb forms—has served as a dynamic strategy of accumulation for centuries. And as Goldman Sachs' $250 million investment in the Willow Rock Energy Storage Center indicates, new forms of storage are emerging as alluring sites to “fix” capital in the name of decarbonization (and, of course, profit). Given such trends, I contend that beyond a revealing frame for orienting future empirical work, a focus on storage also holds the potential to connect and collectively theorize the growing range of projects connected with efforts to mitigate or adapt to the impacts of climate change. Carbon capture, renewable energy “storage,” novel forms of water containment, and permanent spent nuclear fuel storage are all drawing increasing interest and investment in many corners of the globe. Approaching such initiatives through the analytic of storage offers an opportunity to more coherently account for the growing impetus to hold certain materials still—thus allowing others to remain in rapid motion.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

ENDNOTES

1. As this description suggests, electricity cannot be physically stored like a fish or a gallon of water. As Gretchen Bakke helpfully explains: "the 'storage' we do have (and here I am switching from problems of language to problems of physics) is not of electricity exactly, but of electrically driven mechanical processes that can be reversed to regenerate an electric current" (2019, p. 30). This holds true of the lithium-ion batteries, pumped hydropower complexes, and compressed air storage facilities all widely cited as electricity storage "solutions." Even so, given that these assemblages are widely discussed and understood as vitally necessary storage nodes within energy grids, I approach them here as spatially significant sites of storage.
2. Embedded in this focus is an analytical distinction, between the storage of materials and the "fixing" of surplus capital in the built environment, in David Harvey's (1981) sense. As the foregoing analysis demonstrates, in practice the lines between these categories become blurry, as many arrangements of material storage serve to infrastructurally fix enormous amounts of capital. However, as space constraints prevent a full elaboration of both categories and capital fixing has received far more attention within the literature, here I build the analysis from material storage arrangements. Future work could present a more robust elaboration of the relationship between these two categories, fruitfully examining resonant dynamics that mark real estate investment (as helpfully suggested by Reviewer 2).
3. In his account of the accumulation and circulation of avian flu viruses and associated vaccines, Frédéric Keck suggests a slightly different relationship between the terms storage and stockpile than the one outlined here, defining storage as a practice that "produces value in a relation to a conserved past" (2020, p. 139). To date, the broader usage of storage outlined above is far more common across the literature.
4. As Orenstein also notes, Karl Polanyi likewise threads storage-for-use into his account of pre-capitalist forms of redistribution in The Great Transformation (1944, pp. 48–51), drawing liberally on Bronislaw Malinowski's Argonauts of the Western Pacific (1922) in the process.
5. I am grateful to Reviewer 2 for urging my engagement with the topic of storage "in motion," a notable lacuna in an earlier draft of this manuscript.

Biography

Sayd Randle is an Assistant Professor of Urban Studies at Singapore Management University. An ethnographer and political ecologist, her research explores the spatial and cultural politics of urban climate adaptation.

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