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Public Water System Governance in Rural Montana, USA: A 'Slow drip' on Community Resilience

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ABSTRACT
Recent waves of U.S. federal waterworks investments aim to repair material as well as socioeconomic deficits. Yet a growing recognition of the central role of local capacity in successful water resources and infrastructure governance raises questions about the extent to which such investments will engender more resilient rural communities. Synthesizing resilience theory with the drinking water governance literature, we use qualitative methods to assess the social, economic, and environmental dimensions of public water system governance in a case study of six small towns in an agricultural region. We find that shortfalls in local social and economic capital constrain localities from adapting to environmental vulnerabilities, and that the current policy environment exacerbates—rather than ameliorates—tradeoffs between community capitals. In addition to funding increases for rural infrastructure deficits, this study implies that process reform in water quality compliance and financial assistance program delivery will also be needed to bolster rural community resilience.

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Introduction

In 2021, the Biden-Harris administration authorized over U.S. $100 billion for water and wastewater infrastructure improvement across the United States (ARPA 2021; IIJA 2021). Such a momentous shift in federal infrastructure investment was overdue. Through repairing longstanding deficits in the material quality of water and other infrastructural systems, current policy directions aim to simultaneously repair interwoven social, economic, and environmental problems endemic to underserved communities—including in rural and remote regions (The White House 2022). Federal laws such as American Rescue Plan Act (ARPA) and Infrastructure Investment and Jobs Act (IIJA) typically increase funding to existing water infrastructure programs (e.g., State Drinking Water Revolving Funds) or authorize new programs which replicate policy designs with demonstrably uneven results in rural regions (The White House 2022). Thus, given the overlapping aims in infrastructure development and rural development evident in

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current policy initiatives, there is a need for scholars to examine the *intangible* burdens and barriers associated with well-intentioned public investments which aim to deliver *tangible* improvements to rural communities.

Localities' ability to successfully access and develop federal funding opportunities to improve local drinking water service is highly contingent on the preexistence and interaction of local capacities and resources which are highly variable from place to place (Community Strategies Group 2022; Flora 2009). More specifically, research on Small Drinking Water Systems (SDWS)—defined as public water delivery networks which serve less than 500 people (U.S. EPA 2021)—emphasizes the importance of local financial, knowledge, and leadership capacities for entities navigating top-down regulation and funding programs (McFarlane and Harris 2018; Breen and Markey 2019). Resilience theory asserts that such capacities are central variables in rural communities' ability to adapt to changing and challenging circumstances (Flora, Flora, and Gasteyer 2016). The SDWS governance literature identifies linkages with local capacity and resilience mainly through case studies outside the United States (e.g., McFarlane and Harris 2018; Breen and Markey 2019). Yet little is known of the interaction between community capacity and SDWS governance in U.S. institutional context, where local governments are largely responsible for infrastructure management and where the central state acts as both regulator and financier (Flora, Flora, and Gasteyer 2016).

This paper employs resilience theory as a conceptual lens to interpret the extent to which community social, economic, and environmental capitals are developed and intertwined through SDWS program implementation and decision-making processes in a rural setting. We employ a qualitative, regional case study design focusing on SDWS governance, defined for our purposes as the processes by which local-scale institutions and civic actors interact with and implement state and federal drinking water programs (McFarlane and Harris 2018). The paper proceeds as follows. First, we synthesize community resilience theory and the SDWS governance literature to develop a heuristic device for interpreting community resilience outcomes associated with SDWS governance (Table 1). We then apply this framework to a regional case study of six small towns which exemplify common challenges of SDWS governance in rural context: low (and shrinking) populations, high per capita costs of infrastructure delivery, and chronic water quality deficits.

By analyzing the effects of drinking water governance on community capacity, we pinpoint feedbacks between local social, economic, and environmental dynamics and state- and federal-government policy programs—identifying what we call a "slow drip" on community resilience. Our analysis suggests that SDWS governance within existing U.S. policy frameworks may overburden institutional capacity in low-population rural regions and force interconnected tradeoffs between social, economic, and environmental capitals, diminishing community resilience. This case study raises questions about the extent to which aggressive federal infrastructure investment can simultaneously build more resilient rural communities if delivered through existing program structures. In addition to (needed) funding for physical improvements to rural water systems, reforms in program design and implementation will also be necessary to improve rural community resilience.

Community Resilience and Drinking Water Governance

Magis (2010, 402) defines community resilience as "the existence, development, and engagement of community resources by community members to thrive in an environment

Table 1. Resilience principles in SDWS governance and policy.

Characteristics of a resilience-enabling policy environment		
Preserves latitude for local leaders to act on desired local development visions		
Policy requirements do not produce lock-in or perpetuate mal-adaptive development pathways		
Programmatic avenues to support communities in overcoming infrastructure, fiscal, and capacity shortfalls		
Implications for resilient SDWS governance across three key community capitals		
Social capital	Environmental capital	Economic capital
Leadership proactive in problem solving	Water quantity and availability do not produce negative public health effects	Basic infrastructure construction, operations, and maintenance within fiscal means of the community
Infrastructure improvements are subject to inclusive, democratic decision-making processes	Built environment itself does not pose public health threat (e.g., lead pipes; water sources and storage facilities sited sufficient distance from possible contamination source)	Finance mechanisms are stable, reliable and do not create fiscal cliffs or produce maladaptive lock-in
Water services accessible to all (financially and physically)		
Local human capital and knowledge capacity adequate to administer all phases of infrastructure life cycle	Proactive water resource and environmental management to protect public water sources	Built environment right-sized to present and future needs
Communities perceive autonomy to act on land use planning and capital improvement planning decisions	Water quantity needs can be sustainably and reliably met by local water sources	Capital improvements align with place-based economic development strategic vision
Communities demonstrate innovation in problem solving		Non-quantified costs of infrastructure governance (e.g., volunteer time/effort) are attainable
Local desires for future development are institutionalized and operationalizable (e.g., through plans, regional development organizations, etc.)		

characterized by change, uncertainty, unpredictability, and surprise." Flora, Flora, and Gasteyer (2016) categorize such resources across seven community "capitals": natural, financial, built, social, human, cultural, and political. Such capitals may be broadly summarized as a community's social, environmental, and economic resources (Wilson 2012). Resilience theory holds that, in the face of uncertainty and disturbance, communities on resilient development pathways will enhance and balance social, economic, and environmental outcomes by mobilizing an interconnected network of local capacities (Norris et al. 2008; Wilson 2012).

Resilience is also characterized by the extent to which a community's social, economic, and environmental capitals are put into action to respond to change (Magis 2010; Norris et al. 2008). Social capital—i.e., the extent to which community members feel connected, included, and trusted—directly affects the mobilization of other community resources (e.g., knowledge, financial capital) for adaptive outcomes (Kulig, Edge, and Joyce 2008). Resilient communities leverage their assets through proactive leadership, democratic processes, and inclusive problem solving to keep the community moving toward a shared vision (Kulig et al. 2013; Flora 2009), making local agency and decision-making autonomy critical attributes of resilient systems (Berkes and Ross 2013; Magis 2010).

While local-scale factors such as social capital influence community resilience pathways, dynamics beyond the community—such as senior government policy, market fluctuations, and climate change—also shape local resilience trajectories. Wilson (2012) argues that levels of local resilience attributes over time are determined by an interplay between exogenous forces and endogenous social, economic, and environmental variables. Accordingly, policy and the implementation process can enhance or deplete local resilience. Resilience-enhancing policy attends to local needs, respects local autonomy, and enables inclusive, democratic decision-making (Wilson 2013; Ray 2000). On the other hand, resilience-depleting policy may constrain local autonomy, entrench lock-in to mal-adaptive development pathways, or preclude communities from sustaining local capitals (Wilson 2013; Roemer and Haggerty 2021). Given resilience theory's emphasis on local autonomy (Berkes and Ross 2013), policies could impede local resilience if they inhibit local political leaders' agency to respond to change with adaptive, locally-supported solutions (Halseth, Markey, and Ryser 2019).

Resilience Dynamics in Small Drinking Water Systems (SDWS)

With its focus on the interactive dynamics of multiple scales of governance, resilience theory is a salient analytical tool to approach SWDS management. SDWS governance operates at the nexus of environmental, economic, social capitals (Flora 2009). In addition, senior government policy strongly influences local-scale outcomes of SDWS governance (Breen 2016). Household water access forges obvious connections between public health and environmental quality, motivating source water protection efforts and technological improvements to infrastructure to ensure good quality tap water (Morckel and Terzano 2019). Most often managed by local governments in the United States, waterworks are public capital assets which circulate public spending and revenue, making them critical to the development of both financial and built community capitals (Flora, Flora, and

Gasteyer 2016). As critical infrastructures, water systems' functionality depends on ongoing decision-making throughout their lifecycle (Howe et al. 2016). Consequently, water systems are local human capital-intensive—i.e., dependent on local assets such as formal education, skills, knowledge, and leadership potential (Flora, Flora, and Gasteyer 2016, 110). The highly local dynamics of water systems leads scholars to emphasize the need for democratic decision-making and long-range planning in municipal water services and infrastructure development (Morckel and Terzano 2019; Dobbin 2020; Flora 2009).

SDWS often exhibit high costs per capita due to their low usership base (Breen and Markey 2019; Syssner 2020). In small rural communities, the capital costs of system improvement may outstrip local fiscal capacity (Baskaran 2021). Public water delivery requires workers to have diverse skill sets not easily found in remote and isolated places; skilled water technicians and administrators experienced in public finance are essential to basic operations (Doyle et al. 2018; McFarlane and Harris 2018).

While the SDWS governance and community resilience scholarship share many common themes, research focused on their relationship is limited. Senior government drinking water and infrastructure policies have been shown to inhibit communities from enacting innovative solutions to place-specific problems in rural British Columbia (Breen and Markey 2019). Haggerty et al. (2021) explore the connection between cultural capital and community resilience by demonstrating how intergenerational memories of water hardship shape drinking water decision making in SDWS governance. Flora (2009) argues local drinking water management involves all seven community capitals (Flora, Flora, and Gasteyer 2016), and that sustainable drinking water governance should be participatory and move a community toward its shared vision for the future. Environmental, social, and economic capitals should theoretically be balanced in supporting the environmental-infrastructural goal of reliable and clean public water delivery. For example, infrastructure development decisions which support resilience should align with existing community plans, social circumstances, and economic development aspirations.

Themes in the SDWS governance and resilience literatures point toward clear linkages between the two processes (Table 1). Despite theorized connections, more empirical work is needed which questions how senior government drinking water policy interacts with local social, economic and environmental capacities in the U.S. context—particularly in rural areas where such resources risk being underdeveloped. The following case study uses the heuristic presented in Table 1 as a baseline to assess the extent to which such qualities are developed and intertwined through SDWS governance in an agricultural region in the state of Montana, USA.

Methods

Case Study Description

This is a regional case study which includes six rural communities in the Judith River watershed in Montana—a remote region of the United States which exemplifies quintessential challenges of rural public service delivery. The research is designed to analyze SDWS governance across a set of extremely remote towns (populations <50–350) which navigate similar policy, environmental, economic, and social contexts.

Our analysis targeted all SDWS in the Judith River watershed which collect rate payers from users. Public water systems in the region which exceeded the SDWS population threshold of 500 users, and public water systems which do not collect rate payments (e.g., schools, privately operated businesses, and campgrounds) were excluded from our sample because their governance would not reflect the community-scale resilience dimensions examined in this study. Seven public water systems in the region met our criteria and were targeted for analysis. One SDWS yielded no responses to interview requests, and thus this case study includes the six SDWSs where we successfully gathered interview data. We use pseudonyms to reference towns in our analysis to protect research participants' anonymity. Our study's six communities face source water quality and availability challenges typical of the Northern Great Plains (Jackson-Smith et al. 2018); water quality is poor, and water availability may be seasonally inconsistent and affected by long-wave drought cycles.

Public water delivery is typically a responsibility of local governments in the United States (Baskaran 2021). In incorporated small-town contexts such as those represented in the Judith River watershed, water services are overseen by local elected officials (e.g., mayor and city councilors) and carried out in the executive branch of local government (e.g., a public works or water department). In the remote communities of the Judith River watershed, local elected officials are typically volunteers and municipalities and special districts may employ one or two full- or part-time public works employee(s) to operate the water system and administer other public works programs. While local water managers are responsible for daily operations and compliance of the water system, elected officials' responsibilities lie in long-range capital improvement planning and funding development for infrastructure improvements. Water systems in our sample which serve unincorporated communities (i.e., systems not associated with municipal governments) are governed through a special district structure consisting of an elected volunteer board. These systems typically employ one part-time water manager for system operations.

In the Judith River watershed, socioeconomic conditions compound environmental challenges in the sense that the region's residents are older and less wealthy than the national average, and the region faces long-run population decline—limiting financial and human capital needed to govern water services effectively (Table 2). The two counties in the Judith River watershed have lost 14.4% of their population since 1970 (U.S. Department of Commerce 2021). The combined median age of 53 in the six towns in our sample is 15 years older than the median age nationally (U.S. Department of Commerce 2021), reflecting a "graying" demographic structure typical of contemporary US rural geographies. Median household incomes for sample towns range from 43 to 91% of the national average, and personal income growth over the past five decades has been five times slower than the national average (U.S. Department of Commerce 2021).

Data Collection and Analysis

This study relies on data from key informant interviews (n = 36) and secondary documents. First, we used online databases and publicly available information provided by the Montana Department of Natural Resources and Conservation and the Montana

Table 2. Public water system summary of case study towns.

Town	Population (2020); municipal (M) or special district (D)	Median household income (MHI); percentage of U.S. national MHI	State of public water system (PWS)	Monthly water base rate 2017;2021
Masonville	295; M	U.S. $32,188; 40%	Major PWS upgrade 2020 for U.S. $2 million which addressed microbial contamination, however, nitrate contamination is ongoing and requires additional remediation measures.	U.S. $49.10; U.S. $52.37
Spaulding	125; D	U.S. $25,833; 32%	Historic contamination from iron, sulfate, and manganese. New PWS constructed 2005 to address iron. Water currently does not undergo additional treatment.	U.S. $35; U.S. $35
Davenport	235; M	U.S. $34,583; 43%	No PWS; households rely on individual shallow wells. Nitrate, iron, fluoride, sulfate, and microbiotic contamination. Households responsible for own water testing. Lack of PWS limits future growth of community.	n/a
Finlay	<100; D	U.S. $46,667; 58%	Historically, water was good quality, but concerns about shallow well drying up during drought led to construction of new deeper well in 2002. Costs to operate and maintain new well were prohibitive to community so they returned to older well after drought ended.	U.S. $25; U.S. $30
Higgins	350; M	U.S. $52,366; 65%	New deep well drilled 2020 to improve source water quality, particularly iron contamination, and reliability for ~ U.S. $2 million.	U.S. $33; U.S. $95
Meeker	100; M	U.S. $25,208; 31%	PWS established 1964 and updated in 1989. PWS system was not large enough nor powerful enough to supply all households and businesses. Improvements to system in 2020 improved quantity and pressure of water for U.S. $1.5 million.	U.S. $31; U.S. $35

Data sources: U.S. Department of Commerce 2021; Montana Department of Environmental Quality 2019, 2022; Miller 2022; also based on interview and personal communication data.

Department of Environmental Quality to compile background information on the legal and technical characteristics of each SDWS. We also conducted interviews with community partners, university researchers, and regulatory personnel to bolster our background knowledge ($n = 9$). This background information collection effort clarified to the research team that the SDWS governance process included social, economic, and environmental dimensions and justified our use of community resilience as an analytical framework for subsequent interviewing and data analysis.

The team developed a semi-structured interview guide based on community resilience theory and conducted 27 semi-structured interviews with local government key informants in February 2020 as part of the Consortium for Research on Environmental Water Systems (CREWS) project, an interdisciplinary effort to examine water quality and governance in rural communities across the state of Montana. Interviews were conducted with local stakeholders directly involved in public water decision making and service implementation in their respective towns, including local water managers, city councilors, and mayors. We also interviewed 6 members of partnering entities (i.e., nonprofit economic development and water quality organizations, engineering firms, state natural resource agencies) who provide technical assistance to communities. Most local interviewees ($n = 16$) represent past and present civic personnel in the town of Masonville, as the CREWS project targeted Masonville for deeper investigation due to a decades-long history of noncompliance with nitrate regulations. At least two participants representing current leadership were interviewed in Spaulding, Davenport, Finlay, and Meeker. Higgins yielded only one willing and available participant; and the seventh SDWS in the region yielded no responses to interview requests. The onset of the Covid-19 pandemic in March 2020 halted in-person data collection and limited our ability to pursue additional respondents aggressively. Nonetheless, the extremely small population context meant that through only one to three interviews (at times with multiple participants), the research team could fully engage with current local water leadership.

Interviews lasted from 60 to 120 min, and explored participants' direct experience implementing water quality regulation and infrastructure finance programs. Through structured and unstructured questions, interviewees were questioned about the extent to which existing programs successfully addressed environmental vulnerabilities in their communities, the effect of such programs on local water users (i.e., water rate changes, tangible improvements to water quality), the process of financing infrastructure improvements through existing assistance programs, and the practicalities of day-to-day system operations, including how and by whom decisions are made. Interviews were conducted in person, audio recorded with permission and subsequently transcribed.

Transcribed interview data were analyzed using an iterative process which enabled both deductive use of resilience theory and allowed for emergent themes. First, four members of the research team read and summarized the interview transcripts without the overlay of theory for the purposes of codebook development. Then, the team co-created a codebook which included both deductive codes from the SDWS governance and resilience literatures (resembling the heuristic presented in Table 1) and emergent codes. In the second round, three members of the research team used the codebook to identify instances where SDWS governance and program implementation influenced local-scale social, economic, and environmental capitals. The full research team conducted three meetings throughout the second phase of transcript analysis to refine codes and address discrepancies in their application.

After initial phases of interview transcript analysis, secondary data on state and federal legal requirements for public water management were collected and synthesized as a policy memo. To finalize the analysis, two of the authors undertook a final round of deductive coding using the Table 1 heuristic on all fieldnotes, interview transcripts, and the policy memo to pinpoint feedbacks between social, environmental, and economic themes, and endogenous and exogenous resilience processes (Wilson 2012).

Environmental, Economic, and Social Capitals in SDWS Governance

Here we evaluate how exogenous policy factors interact with local environmental, economic, and social resilience variables in SDWS governance in the Judith River watershed.

Environmental Capital in SDWS Governance

Water Quality Conditions and Regulation

Poor quality and inconsistent supply are persistent drinking water issues for rural towns in the Judith River watershed. The semi-arid region has a longstanding history of agricultural production which compounds endemic poor water quality issues associated with the region's soil chemistry (Jackson-Smith et al. 2018). Nitrate contamination connected to the region's agriculture industry is a recurring culprit that affects some, but not all, public water supplies in the region (Jackson-Smith et al. 2018)—resulting in episodic infractions of the Safe Drinking Water Act (SDWA). SDWA authorizes U.S. Environmental Protection Agency (EPA) to set thresholds for mineral and microbiological drinking water contaminants which threaten human health; for nitrates the Maximum Contaminant Level is 10 mg per liter. Nitrates are a public health concern because they have been linked to methemoglobinemia ("blue baby syndrome"), certain types of cancers, and birth defects (Ward et al. 2018). Public water systems in the region without nitrate contamination issues still contend with highly mineralized water, with poor esthetic qualities in color, taste, and smell. Some systems exhibit microbiological contaminants which require disinfecting treatments (e.g., chlorination); other systems in the region without documented histories of microbiological contamination do not disinfect their water. The quantity of source water available is also at times uncertain for Judith River watershed communities, which often rely on shallow groundwater wells as public water sources. In community resilience terms, the persistently suboptimal and potentially harmful condition of the region's drinking water sources represents diminished environmental capital (Wilson 2012).

The SDWA (1974, reauthorized 1996) and associated EPA programs are the main policy drivers of drinking water quality outcomes and SDWS operations in the Judith River watershed. Across the U.S., all drinking water systems consistently serving more than 25 people are considered Public Water Systems and are subject to the Act's requirements. Enforcement of EPA drinking water quality standards is carried out at the state level; in Montana, this is the work of the Department of Environmental Quality. Public drinking water standards are regulatory mandates—they are non-negotiable for local water managers, which test water samples regularly for various contaminants including nitrate. State regulators may require water managers to employ technological and infrastructural upgrades (e.g., filtration, reverse osmosis, chlorination, pipe replacement, or other treatment processes) to ensure public water does not pose health risks.

Navigating Environmental Vulnerabilities

Prescribed infrastructural upgrades range in cost from < U.S. $1 million–U.S. $2 million for the towns in the Judith River watershed. This capital cost is high for rural locales with narrow population and tax bases and low borrowing capacity (Baskaran 2021). For the town of Higgins, developing a reliable and high-quality water supply was worth the financial investment. Higgins, population 350, upgraded their water system for U.S. $2 million by drilling a 3,000-foot deep well to access a new aquifer, which necessitated the town carry some of the highest water rates in the region at a base of U.S. $95 per month (Interview, Higgins 1). It is notable that Higgins' median household income is the highest of any town in our sample, meaning households in Higgins potentially have expanded financial capacity to absorb water rate increases (Table 2). The town water manager described how the politics of the town's decision to invest in significant capital improvements related to the town's history of water hardship:

> First we said we were going to [drill a deeper well to get] better water … We were talking about [drilling the well] and everything, God, there must have been 30–40 people at the meetings. And they were all in agreement … and the rates were going [to go] up. And [the public] understood that. Then we would have good water. Before that we weren't having enough water in summer time, even for fire protection or anything. (Higgins 1)

For Higgins and other towns in the region, the precondition of diminished environmental capital frames public water supply decisions in the Judith River watershed region. While Higgins accepted the debt burden and decided to build, for the other towns in our sample, the question of whether and how to invest in the local water system was not as well supported.

Masonville's water supply has a history of Nitrate contamination and SDWA non-compliance, with nitrate levels exceeding five times EPA standards in recent years (Haggerty et al. 2021). Masonville, population 265, completed their new water system in 2020 for a total cost of U.S. $2 million (representing a per capita cost of roughly U.S. $7,000). Unlike Higgins, public officials in Masonville describe how drinking water compliance programs "pushed the community to [upgrade the water system]" (Masonville 7). Local decision makers questioned the investment due to concerns about the financial impact on resident households, particularly senior citizens living on fixed incomes. Masonville 10 describes:

> [The water system upgrade] is going to help [the consistency and quality of Masonville's water supply] an awful lot. The problem is it leaves the community with a financial burden. These communities … are losing population … and we are an older community. It just puts a harder burden on the people who are left here.

This quote highlights a core tension between the economic costs of infrastructure upgrades and the social realities facing Judith River watershed towns. Towns in the region reflect demographic trends witnessed across many remote regions in the continental United States in that populations are aging and shrinking. Residents have witnessed first-hand the decay of the family farm and watched local businesses shutter. One city councilor relates the town's interpretation of the new water project to material changes to the local economy:

> [Masonville residents] are concerned. It isn't just the water project, it's the survival of the town. You know the grocery store is for sale. The odds of it selling are nil, it might just

> close. We lost our hardware store … You can't go down there anymore and get a cake pan for a shower present, things like that … And so I think there's concern over where we're going to be … How many people are going to live here in 5 [years]? There's no jobs, there's no economy here. Nothing! (Masonville 7)

While previous quotes show how SDWS planning responds to environmental preconditions, this quote makes clear that participants also understand local water supply infrastructure upgrades in relation to their towns' socioeconomic position. The context of population and economic decline (perceived and actual) makes planning for built infrastructure upgrades with lifespans of several decades extremely difficult—and, quite reasonably, a potentially questionable investment from a local decision maker's perspective. Why pay for a water system large enough to serve 200 people when in the future there may only be 50 people? Yet, drinking water regulation may give local civic leaders little choice but to invest in state-of-the-art upgrades to ensure public health. A participant from the town of Finlay describes this planning conundrum:

> "So I was talking with the [Department of Environmental Quality] about [water quality testing] … I said what happens if we fail this test? [They said] well you'll be required to put in a water treatment plant. I said, you think we're going to spend millions of dollars on a water treatment plant to serve 40 people?!" (Finlay 1)

The precondition of diminished environmental capital in the region—on its own and as it is regulated in drinking water quality compliance programs—motivates infrastructure development in the rural towns of our sample. Local political actors sense dual civic responsibilities to provide quality drinking water services to residents, and at the same time to protect their small and shrinking constituencies from undue costs. However, infrastructure planning decisions are complicated by the low financial capacity of extremely small towns and their present socioeconomic conditions of industrial and population decline. Against this demographic context, communities risk overbuilding infrastructure for realistic projections of local needs, and potentially outstripping local financial capacity in the process.

Economic Capital in SDWS Governance

Financing Water Infrastructure in Montana

Public water systems pose a significant capital expense for local governments. In regions with narrow and declining tax bases where the per capita costs of development are high, local governments often rely on outside fiscal support from senior governments (Baskaran 2021). In addition to traditional public works finance mechanisms such as municipal bonds, communities in the case study region leverage financial assistance programs from state and federal governments to make public water system development and drinking water quality compliance possible.

In Montana, four state and federal fiscal assistance programs are available for public water system development, awarding both grants and loans. The programs include: (1) U.S. Department of Agriculture's Rural Development Water and Waste Disposal loan and grant program, (2) the Community Development Block Grant program, (3) the Montana Coal Endowment Program, and (4) Drinking Water State Revolving Fund (Montana Department of Commerce 2020a, 2020b; Montana Department of Environmental Quality

2019; U.S. Department of Agriculture 2017). A review of program budgets and annual awards reveals that demand for financial assistance consistently exceeds program capacity (Montana Department of Commerce 2020b; Montana Department of Environmental Quality 2019; U.S. Department of Agriculture 2020). For example, the Montana Coal Endowment Program budgets to fund roughly half of their projected water infrastructure grant requests (Montana Department of Commerce 2020a). Water and wastewater requests to USDA Rural Development were backlogged U.S. $2.5 billion in 2016 (Baskaran 2021, 57). Each program awards loan and grant funds on a competitive basis, meaning that from a community's perspective, the timeline for securing capital is uncertain.

A single project generally relies on multiple sources of capital, complicating the utility of the competitive award model. State and federal fiscal assistance programs are designed to interact with one another to an extent; for example, the Montana Coal Endowment Program offers U.S. $500,000–U.S. $750,000 grants which include the stipulation that the grant dollars must supplement other capital sources and not finance a project in full (Montana Department of Commerce 2020a). Thus municipalities must be successful in multiple award processes, often within the same fiscal year, to finance a waterworks project.

Accessing Infrastructure Finance Programs

Communities and technical assistance partners in the Judith River watershed have learned to anticipate a cumbersome process. A leader from Masonville explains the inefficiencies of their funding process:

> It's been doodling on for like five years. And we missed the first [funding cycle] … because they only funded the top 25 projects. So then we had all the projects in place and everything and didn't get our funding. So then it was back to square one. And then of course regulations changed. So we had to start over with the engineer. And then on the second go around through the state funding cycle, we were ranked third. We finally got our funding … but yeah it's discouraging at times. (Masonville 3)

This is a typical experience for rural communities competing for public works funding in Montana. Interviewees describe the time, effort, planning and engineering resources, and knowledge needed to put funding applications together. None of the communities in our sample have a city planner—much less an engineer—on staff, and many of the local civic leadership personnel (including city clerks and elected officials) are part-time employees or volunteers. Thus, communities rely heavily on outside technical assistance partners, which sometimes incur remuneration costs. (The regional economic development corporation, nonprofits, and state agency personnel do not charge for technical assistance, but all communities in our sample worked with private engineering companies, which charge for their services.)

Yet even with high-quality technical assistance, the process of obtaining funding remains drawn-out and inefficient, as an employee from a partnership organization explains:

> Bailey had all of the funding in place except for [US Department of Agriculture Rural Development grants and loans]. And they lost it all. So we went through that process. Then they did it again. And they had to change their plan. They got it all in place. They had [state funding] … They were on the list and [the state program] ran out of money. So now they have

> to go back in again for all these funding sources. So [the town has] put in basically 3 sets of applications and it's such a waste of our time and resources. (Partner 5)

This quote demonstrates how the process of navigating funding from multiple programs for public drinking water infrastructure draws on local capacities and social capital. The process requires a high degree of knowledge capital and simply time and effort to manage multiple applications at once (Doyle et al. 2018)—which is compounded when communities must repeat the application process or apply to multiple programs at once. Since a project's completion hinges on success in multiple competitive awards, the exercise of financing public infrastructure development can create wastages of local social capital in rural communities where such capacity is already thin.

Inefficiencies in the funding process also prolong project timelines, leaving environmental vulnerabilities unresolved, and perpetuating exposure to public health risks. A state agency partner describes:

> A town of 800 people with a project of $5–$5.5 million [might not] get their project funded within 4 years honestly. [And the town says] "What? We have this awful water for four years? How are we going to deal with that?" Which I think is a valid point. [The state] does not do a good job setting up a short-term measure to ensure they have safe drinking water until the more permanent solution is implemented. (Partner 4)

Communities may essentially become hamstrung from addressing known environmental vulnerabilities and enacting locally-desired solutions because they lack the capital to act. A former leader from the town of Davenport describes having knowledge of drinking water contamination issues and a desire to improve, but no viable fiscal avenues. Resigned, Davenport 2 said, "[We have] all this contamination here. Here we sit, 265 people … and we can't afford the water system."

In sum, the administrative dimensions of financial assistance programs result in inefficient usages of local knowledge, leadership, and technical capacities, and potentially elongate communities' exposure to environmental hazards. As local leaders endeavor to align multiple funding streams, they apply to the same programs multiple times, and critical capacities are taxed beyond reason. Communities and technical experts plan on waiting several years to finance an infrastructure project through state and federal assistance programs which lack the giving or lending capacity to fully fund all requests. Yet extremely small communities with low financial capacity rely on such programs to generate the capital needed to make such improvements; most communities have little choice but to apply again until their requests succeed. When communities cannot access the capital they need to enact local development visions, they are constrained from responding adequately to environmental vulnerabilities and improving the quality of local capital assets and the built environment—both critical community resilience variables.

Social Capital in SDWS Governance

The previous sections described how environmental and economic drivers interact with social variables in rural drinking water management. This section dissects the social dynamics at the local level which shape and reflect the implementation of environmental and fiscal assistance policy programs. Here we explicate three themes: (1) that program implementation necessitates reliance on multiple public and private partners external to the community, (2) that local leaders make capital improvement planning decisions through a lens of place-based socioeconomic and demographic circumstances, and (3) that the process of managing a town's water supply produces psycho-social and affective responses in local leaders which influence perceived agency.

Outsourcing SDWS Governance

Interviewees describe governance and legal processes which are so technical that communities are unable to navigate the systems on their own. Referencing compliance with EPA's nitrate thresholds, a state agency staff member says:

> [Towns] essentially need to hire a professional engineer to [implement a nitrate mitigation plan]. I said essentially because the rule allows for nitrate source abatement. So if [the town] can identify a nitrate source and get rid of it they could do that without a professional engineer … but it'd be hard for them to do that to be honest. (Partner 4)

Localities tend to rely on the technical knowledge of experts external to the community to implement compliance requirements, project finance programs, and to engineer technological improvements to their infrastructure. Partner 5 described how each town hires engineering consultancies for grant writing, planning, design, and construction processes, while occasionally state agencies or nonprofit partners provide technical support in public finance. Towns may then form dependent relationships with external experts, as a former Masonville councilor described when they said, "I felt all of [the consultants and partner organizations] worked for us to get [the new water system]. We didn't know what we were doing" (Masonville 7).

Thus, stakeholders outside the community are instrumental in policy implementation and decision-making at the local level. The implication is that communities cannot feasibly carry out the breadth of public water works governance processes—a fundamental function of local governments in the United States—by relying on internal capacities alone.

Capital Improvement Planning in a Context of Decline

Developing and maintaining public water systems with lifetimes of several decades naturally prompts decision makers to make projections about the future which are not easily calculated when a town's social and economic trajectory is uncertain. New infrastructure developments are usually engineered with the assumption of economic and population growth, but this is not necessarily a given in remote and peripheral regions (Syssner 2020). And as populations experience natural decline or outmigration, per capita costs of service provision rise. Many interviewees described the squeeze of distributing costs of multi-million-dollar infrastructure improvements across an extremely small population base (Partner 4; Davenport 2). Partner 6 described how a town (population 80) near the study region had to raise the monthly base water rate when one person passed away after the town invested in new treatment facilities. Masonville 10 related affordability challenges to demographic decline, "Well, these little communities are strapped and like I said we're losing population. So we don't have the ability to just tax everybody and pay for it so that isn't a goal … you have to work with grant monies."

As local populations decline, low-income households (potentially limited in their ability to relocate) may make up a higher share of residents. Burdening elderly and fixed-income households with increased water rates—often a necessity when a local government takes on debt to finance capital improvements—was a recurring concern for participants. The town of Spaulding's experience is typical of others in the region:

> The engineering firms come in and do this study and get all this information and [say] this is what your rate should be. [Water rates] were $32 per month before that project and now we're $65 per month … So we went up over 100 per cent. But [the engineers] wanted us to go up to over $90 [per month]. Well a lot of this community is retired people on a fixed income. So we said there's no way we can do this. (Spaulding 1)

Population decline, small usership bases, and water affordability challenges are demographic concerns expressed in interviews which pose practical considerations for public water system management. Given these factors, some interviewees worry that the water system improvements will be overbuilt for future local needs.

Affective Responses among Local Leaders

The SDWS governance process evoked affective responses among local stakeholders, who interpret exogenous regulations as unfair, out of touch with local needs, and restrictive. While high costs per capita are a requisite feature of rural service delivery (Syssner 2020), interviewees also narrate it as a disadvantage which policymakers fail to consider. Meeker 2 articulates this sense of unfairness: "Any of the bigger cities, their projects cost $20 million just like ours does but they have thousands of people to pay for it. We only have hundreds. [Government agencies] don't realize that." In this quote the stakeholder articulates not only an economic disparity between per capita costs, but also a sense that policy programs unfairly ignore rural communities' disadvantages.

Local civic leaders also highlight a mismatch between regulatory programs (which may mandate significant capital expenditures for compliance) and financial assistance programs (which are unreliable). Describing emotions associated with this paradox, Masonville 10 said:

> Yeah frustration was a huge one because what would happen is the state would regulate and then they'd threaten us with a fine if we didn't comply, which makes you comply of course, but we had no way of complying because we didn't have the resources to do that.

Local leaders such as Masonville 10 describe a feeling of being cornered by regulatory requirements, with inadequate support from senior governments to comply. Referring to nitrate mitigation requirements, Masonville 7 says, "I think [the town council] felt shoved in a box … I said to [the town council] there's no hole to crawl down and let this blow over. It's not going to go away. It must be dealt with … There is no wiggling out of this, it has to be done." This quote demonstrates that local leaders perceive a lack of autonomy in their interactions with SDWS regulation and policy programs. Interviewees express concern that regulatory requirements will push their towns toward developments which aren't well supported locally, and projects produce undue financial burdens on local households. Concurrently, local leaders' experience with unreliable fiscal assistance programs influences low perceptions of local autonomy and efficacy—variables of known importance to resilience.

Discussion

This paper used a largely deductive application of resilience theory to understand the effects of SDWS governance on community capacity in rural contexts. Overall, we find that basic drinking water governance processes—a fundamental responsibility of local governments in the U.S. federalist system—diminish local-scale environmental, social, and economic capitals in the extremely small towns in our case study.

Environmental capital is theoretically protected and enhanced through top-down regulations which enforce compliance with national drinking water standards at the local level. This model encounters serious problems the case study region, where localities lack viable financial means to address longstanding water quality and public health vulnerabilities. Specifically, SDWA regulatory programs which penalize localities for noncompliance are poorly aligned with commensurate funding avenues. Lack of funding can be a barrier to water quality compliance in disadvantaged communities—including those with low financial capital and small usership bases. Interviewees in Davenport highlighted this paradox when they emphasized their genuine desire to improve local water quality but described they simply lacked the financial means to do so. Resilience-building policy should theoretically support communities in transitioning away from mal-adaptive pathways (Table 1). To enhance resilience, policy designs might focus on making infrastructure improvements feasible for marginalized communities by providing funding guarantees to support communities in overcoming noncompliance, and building programs tailored to the needs of rural SDWSs.

In addition to highlighting a need for increased funding, our analysis of economic capital makes it clear that the process by which funds are distributed is also salient to resilience. By requiring multiple grant and loan applications to fund a single waterworks project, fiscal assistance programs demand highly inefficient inputs of local social and human capital. Communities see minimal returns on investments of social capital; as they wait for success in the award process, towns are hamstrung from improving the material quality of local infrastructure and environmental vulnerabilities go unabated. As incoming investments from recent U.S. infrastructure laws such as ARPA and IIJA expand funding opportunities, this study highlights a need to consider (1) the costs to local social capital inherent to existing implementation strategies, and (2) opportunities to make senior government funding assistance more certain and reliable. Furthermore, it stands out that SDWA and financial assistance programs explored in this study (with some exceptions in formula funding programs with population thresholds) are largely a-geographic and a-demographic—meaning that SDWS serving 500 or fewer people are subject to the same set of regulatory requirements and rely on many of the same financial assistance programs as public water systems with larger user bases. Policy reforms to build rural community resilience in the drinking water space might consider developing programs which target financially distressed, low-population communities in overcoming economic barriers to adapting to environmental vulnerabilities.

Through SDWS governance processes, decision makers weigh tradeoffs with local socioeconomic realities, rely heavily on outside experts, and perceive a lack of autonomy. Thus, this case study demonstrates how the process of implementing regulatory requirements and navigating fiscal assistance programs produces multidimensional costs to social capital at the local level. Supporting other research at the resilience-drinking water governance nexus, participants in this study did not perceive public water provision as a space where innovations in community development were possible (Breen and Markey 2019), as the expertise required to implement basic requirements exceeded local knowledge and administrative capacity (Table 1). Minimizing administrative burdens through streamlining application and reporting processes and through regional access to robust technical assistance might address such concerns.

The town of Higgins demonstrated more promising resilience outcomes than others in our case study and offers a few lessons. Higgins demonstrated proactive public leadership in adapting to poor water quality, high public engagement in planning meetings, and, notably, greater financial capital than surrounding towns as the electorate supported the highest monthly water rates in the region at the ballot box. Water quality and infrastructure reform was led endogenously rather than enforced by exogenous regulatory requirements. Therefore, the case of Higgins demonstrates how social and financial capital must align with inclusive, democratic process to enable communities to take action to adapt to environmental vulnerabilities (Kulig, Edge, and Joyce 2008; Magis 2010).

In the contemporary U.S. federalist system, rural scholars and policy experts increasingly recognize local-scale social capacity as a critical variable in determining success in water resources and basic infrastructure governance in remote regions (Community Strategies Group 2022; Flora, Flora, and Gasteyer 2016). While this study contributes a nuanced description of the costs to social capital effected by the SDWS governance process in the pre-Covid regulatory environment, it will be important for future research to extend these findings by investigating the extent to which such dynamics are replicated or ameliorated in new infrastructure programs authorized in the 117th U.S. Congress and beyond. As modeled here, future research should maintain a focus on the interplay between social, economic, and environmental capitals throughout the SDWS governance and program implementation process. Perhaps the most compelling contribution of this study for future policy directions is a recognition that quotidian requirements of public water system governance in the United States potentially diminish community capitals critical to resilience in rural settings. Through reforms to funding and technical assistance delivery, program implementation, and enforcement models, drinking water quality regulation and financial assistance programs must account for the interconnected inputs of *soft* infrastructures which make developing *hard* infrastructure possible.

Conclusion

Through a qualitative case study approach, this research investigated the effects of SDWS governance processes on social, economic, and environmental capital in six rural communities of an agricultural region in the state of Montana. The study is motivated by recent substantial U.S. infrastructure investments and a growing recognition that, in the contemporary U.S. federalist system, local capacity is a critical variable in determining success in water resources and basic infrastructure governance in remote regions (Community Strategies Group 2022; Flora, Flora, and Gasteyer 2016). Responding to a gap in empirical knowledge about the effects of public water system governance on rural community capacity in the U.S. context, we argue that social, economic, and environmental dimensions associated with governing SDWSs potentially result in a "slow drip" on attributes essential to community resilience.

In the Judith River watershed, stresses on local economic and social capital constrain communities from proactively adapting to environmental vulnerabilities, and existing policy structures exacerbate rather than mitigate the deficits. Our findings trouble the assumption that financial investment alone will be adequate to reverse trends of decline in marginalized communities (The White House 2022), and rather, point to a need to tailor funding and drinking water program delivery models to address needs unique to SDWS and rural contexts.

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