

Linkages of Suspended Infrastructure, Contestation, and Social-Environmental Unevenness: Colombia's Tolima Triangle Irrigation Megaproject

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ABSTRACT:

Suspended infrastructure of megaprojects marks Latin American landscapes. However, little research has attended to the social-environmental and political-ecological processes of such infrastructure. Moreover, while social conflict often accompanies infrastructure development, our research emphasizes citizen contestation of the suspension and dynamic spatial unevenness as a claim on the state to complete the project. This study examines Colombia's largest suspended irrigation infrastructure, the Tolima Triangle Irrigation District, through a combined political ecology and social-ecological systems framework. Results of integrated analysis show how the suspension drives differentiation in resource use and the social responses of individuals and communities to deepening disparities. In turn, public contestation of suspended infrastructure drives future prospects for the Tolima megaproject. Data is drawn from field research conducted for one year in 2018-2019. Mixed methods included semi-structured interviews, environmental assessment techniques, household surveys, and ethnographic participant observation. The research demonstrates that suspended infrastructure is neither a politically neutral, merely passive backdrop nor void of transformation but rather is comprised of contested processes rooted in the expanding social-environmental and political-ecological unevenness of development. Our findings contribute to the research on infrastructure suspension and development, and they are set within a broader body of scholarship on irrigation and political ecology of Latin American countries.

KEYWORDS: *infrastructure, suspension, contestation, irrigation, Colombia*

RESUMEN

Los megaproyectos suspendidos marcan los paisajes latinoamericanos; sin embargo, pocas investigaciones han prestado atención a los procesos socioambientales y político-ecológicos de las infraestructuras suspendidas. Además, aunque los conflictos sociales suelen acompañar al desarrollo de las infraestructuras, nuestra investigación hace hincapié en la respuesta ciudadana a la suspensión y la inequidad espacial dinámica como reclamo al Estado para que complete el proyecto. A través de un marco combinado de ecología política y sistemas socioecológicos, este estudio examina la mayor infraestructura de riego suspendida en Colombia, el Distrito de Riego del Triángulo de Tolima. Los resultados del análisis integrado muestran que la suspensión impulsa una diferenciación en el uso de los recursos y una serie de respuestas sociales de las personas y las comunidades ante la profundización de las inequidades. A su vez, la objeción pública ante la suspensión del proyecto impulsa perspectivas futuras para el megaproyecto de Tolima. Los datos provienen de una investigación de campo realizada durante un año en 2018-2019. Los métodos mixtos incluyen entrevistas semiestructuradas, técnicas de evaluación ambiental, encuestas de hogares, y observación etnográfica participante. La investigación demuestra que la infraestructura suspendida no es políticamente neutral, ni un mero telón de fondo pasivo, ni carece de transformaciones, sino que se compone de disputas arraigadas en procesos de desarrollo socioambientalmente desiguales. Los resultados contribuyen a la investigación sobre la suspensión de infraestructuras y el desarrollo y se enmarcan en un conjunto más amplio de estudios sobre riego y ecología política en países latinoamericanos.

PALABRAS CLAVE: *infraestructura, suspensión, contestación, irrigación, Colombia*

INTRODUCTION

Across Latin America, governments and development banks are pushing to develop and finance diverse infrastructures (A. Bebbington et al., 2020; D. H. Bebbington et al., 2018). Less discussed but also pressing are the many infrastructure projects in some state of suspension, tallied in a World Bank report (Watkins et al., 2017). Suspended projects range from small to large-scale investments in megaprojects. Uribe (2021) contends most infrastructure projects pass through states of suspension, whether “*rutinos, intempestivos, parciales, totales, transitorios, [o] indefinidos*” (p. 226). In other words, delays or partial completion with a promise

of continuance may be forms of suspension (Table 1 shows a few megaprojects in various states of suspension). We draw on Gutierrez, Kelly, Cousins, and Sneddon (2019) to define megaprojects as hard, physical infrastructures that “call in to effect multiplicity—of temporalities, of spatial scales, of political actors, and ecological relations,” and whose significance may be evaluated in terms of “symbolism, conflicts, and impacts” (p. 105). The often-protracted temporal spans of megaproject construction are associated with changing social-ecological, political, and spatial relations, the processes and impacts of which may involve social conflict. The research presented here examines how

delays in the development of a megaproject irrigation system drive social-environmental contestations over uneven access to resources, at times furthered by the project's suspended status.

Infrastructures are combined social-environmental and political-ecological processes (Carney, 1993; Birkenholtz, 2009; Zimmerer, 2011b; Thomas, 2021). Often a material imprint in the landscape in the form of roads, canals, or dams (Zimmerer, 2011b; Sneddon, 2015), infrastructures are also social-environmental in their use of and consequences for environmental resources (Hetherington, 2018), often taking form as direct landscape reshaping, such as sculpting coastal regions for agricultural production (Carney, 1991; Carse, 2014). Political goals drive infrastructure and social-environmental transformations, as governments and investors establish the desired outcomes of development, the spatial layout, the technological standards and design, and the forms of interactions formally permitted by potential users (Carse & Lewis, 2017; Birkenholtz, 2022). The political-ecological processes of infrastructures reconfigure imaginaries and values of *territorio* (Duarte-Abadía et al., 2015; Hidalgo-Bastidas et al., 2018; Hope, 2022), in part through their symbolism as “promises made in the present about our future” (Appel et al., 2018, p. 27) or symbols of hope for a changed social-economic and social-environmental order (Hetherington, 2016). In addition to spatial reshaping of landscapes, geographers and scholars of cognate disciplines have examined infrastructures' temporal durations of development, including the necessary maintenance and decay of infrastructures'

materials (Schwenkel, 2015; Barnes, 2017; Bresnihan & Hesse, 2020) and the “aspirational mode” that temporal development processes inspire in those anticipating an infrastructure's benefits (Hetherington, 2016, p. 62). Recently, scholars have investigated infrastructures' construction delays due to competing political interests (Thomas, 2020) or financial difficulties, with some suggesting infrastructures are always half-finished or unfinished (Bancalari, 2020; Guma, 2020).

A focus on suspended infrastructure, however, differs from a characteristic of being half-finished in that suspension indicates neither finality nor a static state but instead is future oriented and in process (Gupta, 2018; Uribe, 2021). Carse and Kneas (2019) state the “obviousness of the unfinished as an empirical phenomenon” (p. 10) and encourage scholars to examine what temporality and duration mean for the everyday lives and ecologies of local communities surrounding infrastructure projects (Kneas, 2018). For both vulnerable social groups and potential beneficiaries, contestations of suspended infrastructure can make visible inequitable changes to resource access and serve as a focus of communities' claims vis-a-vis the government (Delgado & Zwartveen, 2008; Harris, 2008). We propose a novel approach across the conceptual bodies of work that investigate the contestation of infrastructure and that focus on suspended infrastructure. Despite the ubiquity of infrastructures in states of suspension, there has been limited attention to how infrastructure development, suspensions of construction, and linked contestations may further deepen social-environmental and political-ecological uneven-

ness. Here we understand unevenness as spatially differentiated social and environmental processes resulting from power inequities (Reed, 2007; Smith, 2010; Ingalls, 2017).

This research is grounded in a combined political ecology and social-ecological systems framework to examine these linkages in Colombia's Tolima Triangle Irrigation District (DRTT), a canal system megaproject intended to irrigate more than 228 km² in an area of southern Tolima. As planned, the water would benefit 7,500 families in a region in which 85 percent of residents identify as Indigenous Pijao and has long been among the country's poorest. The residents largely rely on agriculture for their livelihoods, cultivating maize and drought-resistant fruit trees including mangos and limes. Until Colombia's free trade policies in the early 1990s, the region contributed notable harvests to domestic markets of sorghum, sesame, and cotton.

Starting in the 1970s, residents lobbied the government for the irrigation infrastructure, when two irrigation megaprojects went into operation directly to the north of the Triangle (Baumann, 2022b). In the years surrounding the 2006 groundbreaking, government documents announced that the megaproject would expand agricultural production, thus addressing social needs.¹ Partially completed, the project's construction has been suspended since 2014. Only 10 percent of the canals are built and contain water, but no formal governance exists to regulate the water's use (Baumann, 2022a) (Figure 2). The DRTT is one of multiple suspended megaprojects throughout Latin America, and one of three irrigation megaprojects

in Colombia in an official state of "suspension," whose concrete social-environmental processes exert immediate impacts on communities.

Data is drawn from field research conducted in 2018-2019. Mixed methods included semi-structured interviews, environmental assessment techniques, household surveys, ethnographic participant observation, and textual analysis. Results demonstrate how the stalled processes of the Tolima Triangle Irrigation District contribute to patterns of social-ecological unevenness; how residents contest both the suspended construction and the worsening inequities in resource access and use; and, in turn, how the unevenness drives contestations and contributes to current dynamics and prospects of the Tolima megaproject. We then assess how the suspension may reflect and ultimately serve the Colombian government's political economic infrastructure strategies. The contestations surrounding the Tolima Triangle megaproject and its suspension signal shifts in the Colombian state's infrastructural policies, historically focused on large-scale concrete structures similar to the rural development priorities of other Andean countries (Mills-Novoa & Taboada Hermoza, 2017; Damonte et al., 2021).

In the following sections we build our theoretical framing linking suspension, contestation, and unevenness, as illustrated in Figure 1. We then detail results including evidence of changing water distribution, use, and cropping systems surrounding the suspended project. We illustrate how citizens' contestations of the widening disparities are simultaneous claims on the state for invest-

LINKAGES OF SUSPENDED INFRASTRUCTURE, CONTESTATION,
AND SOCIAL-ENVIRONMENTAL UNEVENNESS

Country	Project Type	Project Name	Year Started	Current State	Contestation	Financing Amount*	Financing Arrangement	Area of Indigenous Peoples?
Brazil	Railroad	Transnordestina	c. 2012	Suspended due to insufficient funds.	Camargo (2015) discusses conflicts in land use and access to potential benefits of the project for small-scale producers.	6 billion reais (\$1.76 billion USD)	About 75% from public funds with additional funds from National Steel Company (Companhia Siderúrgica Nacional).	Unclear
Colombia	Irrigation Hydro-electric Potable Water	Ranchería, La Guajira	2009	Suspended since 2014, Partially completed.	Yes, for lack of water to high-need area and for directing water primarily to areas populated by not-Indigenous Colombians.	Across 20 years \$678 million COP (\$259.8 million USD)	Public works project initially. Included currently in call for public-private partnership to complete.	Yes
Colombia	Irrigation Hydroelectric	Tesalia-Paicol, Huila	2009	Suspended since 2014. Partially completed.	Yes, repeated claims to government to finish district for climate-stressed agricultural zone.	Across 20 years: \$91.1 million COP (\$34.9 million USD)	Public works project initially. Included currently in call for public-private partnership to complete.	No, not primarily
Colombia	Irrigation	Triángulo del Tolima	2006	Suspended since 2014. Partially completed.	Yes, for growing unevenness in land and water access. Additionally, contestation over land use.	Across 20 years: \$693.4 million COP (\$265.7 million USD)	Public works project initially. Included currently in call for public-private partnership to complete.	Yes
Mexico	Potable water (rural)	La Presa Paso Ancho	2011	Suspended since 2014. Partially completed.	Yes, suspension is due to local contestations over land rights and authorization to use land for a dam. Area with 40+ years of land rights conflicts. 30% completed.	\$5.5 billion MXN (\$263.9 million USD)	Public funds of Oaxaca Comisión Estatal del Agua	Yes
Peru	Transportation	Lima Metro	1986	Partially completed: 1 of 6 lines.	Supposed opening of Line 2 in 2022. Significant critique for fiscal corruption and delay.	Lines 3 & 4 promised US\$8.78bn by Peru President.	Public works, also investments from Italy.	No
Venezuela	Energy	Represa de Tocoma	2002	Suspended. 2014 default on loan.	BBC news critiques the suspension and government in light of energy crisis in recent years (Bermúdez, "Venezuela sin luz, 12 mar. 2019).	US\$9,365M	Loan from Corporación Andina de Fomento (CAF) for US\$600mn (2007). Argentine private company Impsa pays debt with US\$1200mn (2018).	No

Table 1. Examples of suspended infrastructures in Latin America, highlighting suspended water infrastructures, two transportation projects, and one energy project with long timelines and receiving attention for their suspensions. For more examples, see World Bank report authored by Watkins et al. (2017).⁸

ment and the completion of the construction. In the discussion, we advance an integrated social-environmental and political-ecological framing of suspended infrastructures. Findings from this research advance ongoing and international discussions in geography, anthropology, development studies, and cognate disciplines centered on the temporal and environmental aspects of infrastructure as well as on the current status and future of infrastructure investments within water infrastructure development in the Andes. The research demonstrates that project suspensions are neither passive nor void of transformation but rather are often contested processes rooted in the expanding political-ecological and social-environmental unevenness of infrastructure development.

THEORETICAL FRAMING: INFRASTRUCTURE GEOGRAPHIES THROUGH THE LENS OF POLITICAL ECOLOGY AND SOCIAL ECOLOGICAL SYSTEMS

In this research we define infrastructure as both a material structure and social-environmental process enabling flows and the circulation of resources over space. We draw on Larkin (2013) to further consider infrastructure as “the relation between things” and “matter that enable[s] the movement of other matter” (p. 329). There has been a recent focus on infrastructure in geography and cognate disciplines, spanning diverse engagements with infrastructure as a material force, an analytic, and a point of departure for various academic inquiries. Lawhon, Nilsson,

Silver, Ernstson, and Lwasa (2018) consider infrastructure in the context of a verb, in that infrastructures work to produce and change ways of connecting (p. 725). As anthropologists and others embrace infrastructure as a point of departure for examining social and economic life (Appel et al., 2018), human-environment geographers have importantly extended our thinking to analyze the power inequities and social-environmental relations as part of infrastructure (Carse, 2014; Thomas, 2021). We build on recent integrative work in geography that recognizes infrastructure’s roles as a social-ecological dynamic of resources, resource users, and governance as well as a political-ecological process of social power, uneven development, and combined resource coordination and contestation (Zimmerer et al., 2022).

Geographers, anthropologists, and cognate scholars have engaged temporal concepts to investigate dynamic relationships that occur throughout an infrastructure project’s development (Appel et al., 2018; Lawhon et al., 2018; Cousins, 2019; Gutierrez et al., 2019). Hetherington (2016) argues that the political power of an infrastructure project lies not in its spatial extent but its temporal extent. Temporal heuristics like suspension and stalled infrastructures permit research questions to examine “sociomaterial relationships and processes” (Carse & Kneas, 2019, p. 11) that unfold at various moments in the project’s development (Appel et al., 2018; Gupta, 2018). Attention to the long timelines of infrastructure development challenges ideas of infrastructure progress as a linear and homogenous movement, instead inviting research on ruins (Stoler, 2013; Howe et al.,

2016), breakdown (Schwenkel, 2015; Wakefield, 2018), maintenance (Furlong, 2014; Barnes, 2017), or corruption and abandonment in the case of “white elephants” (Appel, 2012). Different from a fully abandoned project, a suspended one is premised on a future completion, even if the time of completion is unknown and uncertain. Scholars have shown that stalls and suspensions are often part of the processes of infrastructure development and maintenance (Uribe, 2021), what Correia (2019) terms arrested infrastructures. Our research emphasizes that project suspensions, that is, unfinished or partially completed infrastructures, are neither neutral heuristics nor apolitical (Guma, 2020) but have material outcomes for local residents, including contributing to social-environmental unevenness.

Analyses of the drivers of social-environmental and spatial change, of resultant disparities in resource access, and of conflicts over environmental resources have largely fallen under the framework of political ecology, which emphasizes questions of access to water and its distribution and use (Carney, 1993; Harris, 2008; Zimmerer, 2011a; Birkenholtz, 2013; Boelens et al., 2017). Political ecology has also theorized humans’ reshaping of landscapes for irrigation purposes (Carney, 1991; Zimmerer, 2000) or communities’ adaptations to waterscapes’ fluxes (Zimmerer, 1994; King et al., 2019). The tome of irrigation research illustrates the production of irrigated landscapes through both environmental and social processes (Zimmerer, 2000) as well as their role as producers of social-environmental and spatial differentiation (Birkenholtz, 2009;

Carse, 2014). This research brings studies of irrigation water access and use into conversation with infrastructure geographies and suspension. Unlike large-scale road or dam projects or other more spatially discrete infrastructures (e.g., airports), the suspension of irrigation canal construction, even in a large project, can enable both production and contestation by community-level groups of peasant and Indigenous smallholders within the project area.

Political ecology is widely used by scholars to theorize conflicts over and unevenness of resource use through concepts including equity, governance, and access, and thus opens analysis to the social-political contestations of infrastructure development (Sneddon et al., 2002; Zimmerer, 2017). Dam projects, for example, have been heavily contested at all moments of design and construction (Duarte-Abadía & Boelens, 2016; Hommes et al., 2016; Akbulut et al., 2018; Atkins & Hope, 2021). In his research on large-scale land concessions in Cambodia for the construction of a hydropower dam, Baird (2017) conceptualizes the particularities of local resistance to the project as ‘contingent contestations’. He emphasizes that the form of contestation is dependent on histories, identities, politics, and the particularities of livelihoods.

The contestations characterized by Baird are not singular to dam development but also extend to contexts of irrigation projects. Contestations related to irrigation infrastructure reflect protection of cultural identities, traditional water rights and uses, and communal meanings of *territorio* (Delgado & Zwarteveen, 2008; Mena-

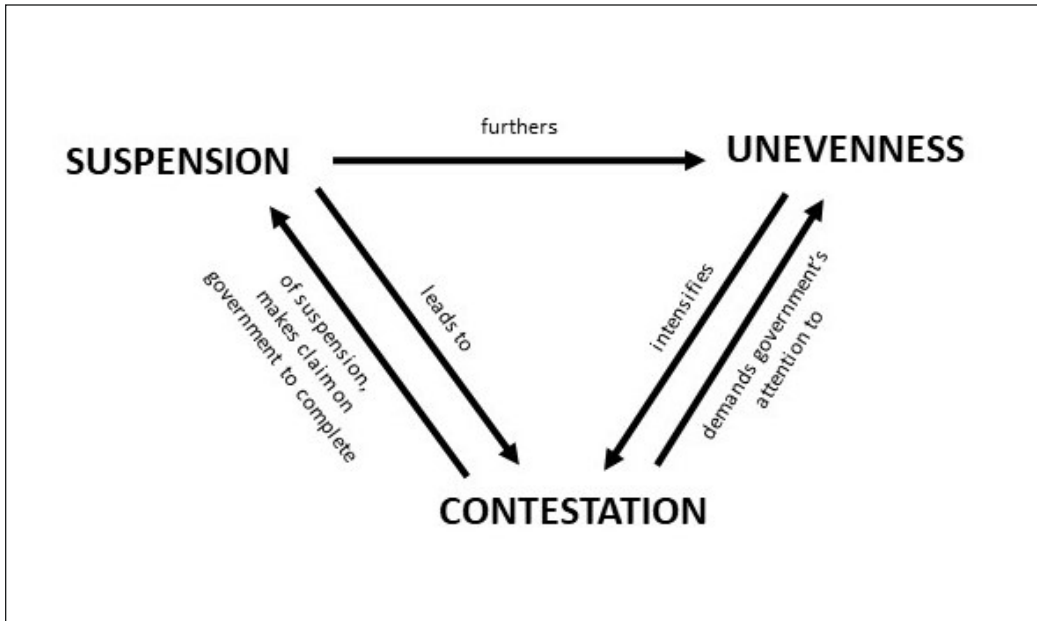


Figure 1. Concept map of dynamic linkages among suspended infrastructure and the social-environmental processes of unevenness and contestation in the Tolima Triangle Megaproject.

Vásconez et al., 2016; Rocha López et al., 2019). Irrigation infrastructure directly affects livelihoods, resource access, and land use and tenure for entire regions' populations (Baumann, 2022b). Differing from prior research on contestation, we identify contestation as tied closely to suspension in formulating citizens' future-oriented goals as claims on the state to realize earlier promises made. In other words, residents' contestation is not in opposition to the project but instead to its suspension and the resultant unevenness, and it acts to hold the government accountable for prior plans.

As the case is set in a region that is home to residents who overwhelmingly identify as Indigenous, we draw insights from political ecology to attend to the politics of identity and relationships to water and *territorio*. Especially throughout research in

Latin America, attention to social differences, specifically indigeneity, has been important to understanding the use of irrigation water. Perreault (2008) shows that issues of water distribution are both material and cultural, enrolling "social identities, systems of meaning, livelihoods, and class-based, ethnic, and regional alliances" (p. 848), and influencing who receives water and in what manner. Zimmerer (2011b) discusses the "social differences [in ethnic and socio-economic identity], power and conflict" (p. 920) present in spate irrigation settlements in the Bolivian Calicanto region that influence cropping choices and inter-community tensions. In many regions throughout Latin America, indigeneity layers onto gender and class to shape experiences with water access and use (Vera Delgado, 2015; Moreno & Montenegro, 2021; Prieto, 2021).

Finally, scholars investigate shifts in state policy and financing through the lens of political ecology, integrating the state's power as an environmental actor into political economic analyses. Importantly, geographers have shown that the state is not a 'thing' but a shifting set of processes and practices (Secor, 2004; Painter, 2006; Meehan, 2014; Loftus, 2020). Infrastructure megaprojects have historically been a tool of state power through spectacle (Luxion, 2017), extension of economic frontiers (Uribe, 2017), and the controlled ordering of social-environmental relations (Scott, 1998; Mitchell, 2002). States' funding, administration, and development of infrastructure as well as the associated prioritization type of infrastructure and intended beneficiaries reflect overarching social-environmental and economic state priorities.

The concept of social-ecological linkages anchors our theoretical framework by directing investigation to interconnected canal construction, water flows, distribution, and cropping patterns. Irrigation infrastructure in particular enrolls and produces interdependent social and ecological systems through elements of landscape reshaping (Carney, 1991; Zimmerer, 1994), governance of water flows and systems (Chambers, 1988; Ostrom, 1993), and irrigation-specific crops (Attwood, 1987; Zimmerer, 2011b). In analyzing changes over time to water availability and crop choice and extension, we investigate how the suspension relates to social-environmental unevenness and propose that contestation to infrastructure is itself a social-environmental process.

METHODS AND METHODOLOGY

The first author conducted field research in the DRTT in December 2017, over eleven months between 2018 and 2019, and in November 2021.² The research was coordinated with Colombian scholars, regional nongovernmental organizations, community groups, and the DRTT's potential water user group, Utritrol. Research took place throughout the DRTT area of influence, with participant observation, surveys, and interviews occurring both in rural areas and in the more populous *pueblos* of Coyaima and Natagaima. Ethnographic participant observation in the DRTT permitted close attention to changing human-environment relationships in relation to land and water resource use. The first author regularly attended community meetings, producer protests, and Indigenous government (*cabildos*) meetings, and she spent significant time in community market halls with producers (Baumann, 2022c). She participated in monthly or bimonthly gatherings of local nongovernmental organizations (NGOs) and grassroots organizations that promote the sustainable use of water and land resources and the *in situ* conservation of native seeds (Reinales & Acevedo-Osorio, 2020).

A survey was conducted with 68 households throughout Coyaima, Natagaima, and Purificación, the municipalities slated to receive DRTT irrigation benefits. Participating households were chosen so as to comprise a spatially stratified sample across the DRTT, divided between the four planned irrigation sectors. The selected sample represented the diversity of cropping systems, land tenure, liveli-

hoods, and social differences including gender, ethnicity, age, and socioeconomic standing in the district. The surveys gathered information on demographics, practices of water consumption and access, livelihoods, cropping systems, inputs used, and experiences of drought.³ Open-ended questions asked participants to describe how they envisioned the DRTT within ten to fifteen years and solicited their principal experienced stressors. To derive further detail from survey data, the first author conducted unstructured interviews (n=45 interviews) with producers of rice as well as other crops within the DRTT. Interviews were also conducted with social leaders, irrigation officials, and government agencies involved with the DRTT. Interviews were designed to elicit the various factors influencing land use decisions such as economic challenges, access to resources, labor, and subsistence needs. Interviews included a focus on constraints and opportunities presented by the suspended irrigation project.

RESULTS

COLOMBIA'S LARGEST SUSPENDED IRRIGATION MEGAPROJECT: EARLY INTENTIONS AND CURRENT STATE

The Department of Tolima is in Colombia's Andean region, located four to five hours by road from Bogotá. The cultural and social center of the Pijao Indigenous group, the geographic region of the DRTT is ethnically unique within the broader region. Within the Triangle's area of influence there are more than 20 reservations (*resguardos*), or government land concessions to Pijao governance

organizations (see map in Baumann, 2022a). The region has long been considered one of the country's poorest, with high rates of childhood malnutrition and very low household incomes. In 2016, Coyaima reported an unemployment rate of 19.3 percent and an underemployment rate of 60 percent (El Concejo Municipal de Coyaima, 2016). In the past decades, there has been consistent out-migration of working-age residents including many seasonal migration fluxes during the long dry season (June-September). Located in a tropical dry forest ecosystem in an Andean valley, producer fields are at an elevation of 300-400m. The bimodal rainy seasons permit two harvests per year of maize, which is central to the culinary traditions of Indigenous and Campesino families.

The unfinished infrastructure is the most recent irrigation megaproject in what has become an irrigation corridor, including multiple small and medium-scale districts as well as three of Colombia's five largest irrigation megaproject districts: Usocoello, Usosaldaña,⁴ and the DRTT (Baumann, 2022b). Diverting water from the Saldaña River, a principal tributary of the Magdalena River, engineering designs anticipate the DRTT will irrigate more than 22,000-ha within the 33,000-ha extent of the project. By some estimates, a completed DRTT would provide irrigation water to more than 19,000 individuals in the municipalities of Coyaima, Natagaima, and Purificación (Table 2).

With initial plans started in the 1970s, construction crews finally broke ground for the DRTT in 2006. The completion of Phases I and II of construction resulted in the 350-ha Zanja Honda reservoir. In late 2014, more

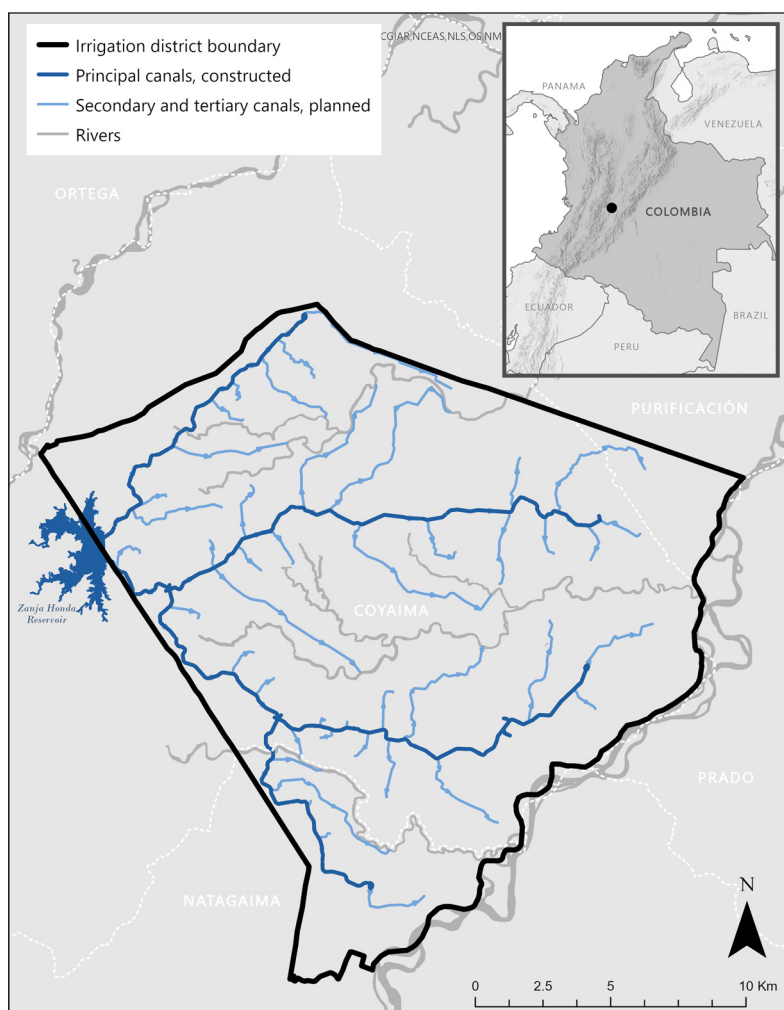


Figure 2. Map of Tolima Triangle Irrigation District: Zanja Honda reservoir fills four constructed principal canals. Secondary canals, seen here, have not been constructed (map by Carly Ringer).

	Coyaima	Natagaima	Purificación
Population (2019)	18,999	14,292	22,682
Percent of district's area	85.8%	9.6%	4.6%
Percent of population that self-identify as Indigenous	>75%	>58%	1,774*

Table 2. Information of municipalities planned to receive water from the Tolima Triangle Irrigation District. Sources include “El DANE reveló cifras del censo” (2019) and CRIT (2020).

* Number of individuals living in Indigenous *resguardos*

than 40 years after the project's ideation, the reservoir's sluiceways first opened to release water into four concrete-lined princi-

pal canals, totaling 66km (Figure 2). With the principal canals complete, the next phases of construction would, according to engineer-

1980s	Engineering assessment and design
2006	Groundbreaking for construction
2012	Phase 1 complete: Intake system, tunnel, conduction, sediment excluder
2014	Phase 2 underway: Principal canals constructed
2015	Government suspends construction
2015	Principal canals filled with water
2016-2018	Boom in rice production
2020	Government opens call for private companies to engage in public-private partnership

Table 3. Temporal life of the Tolima Triangle Irrigation District.

ing plans, establish an additional 575km of canals, including secondary (224km), tertiary (257km), and quaternary (93km), for a total canal network of 640km (ADR, 2020). In sum, ten percent of the total canal infrastructure has been constructed.

At the same time the water entered the main canals in late 2014, the government halted construction and the district has since been in an official status of ‘not in operation’ (Table 3). In practice, “*no está en operación*” means there is no regular maintenance, no water tariffs, and no guarantee of irrigation water. With no formal regulation of water use, it is not legally authorized. The sluiceways from the reservoir allow water to pass through to maintain proper levels in the reservoir, and drainage gates are open to avoid flooding, but there is no regular management of water levels. The canals drain into the three smaller rivers of Hilarco, Chenche, and Guaguarco, tributaries of the Magdalena River. Despite the prohibition of water use, many producers use motor pumps to pull water into canal-adjacent fields. Without the canals of Phase III, however, water access is spatially concentrated along the filled principal canals and corresponding drainage channels, limiting the number of producers able to use the water.

SUSPENDED, NOT ABANDONED: THE GOVERNMENT’S MISMANAGEMENT AND FUTURE FINANCING PLANS

The highly visible disconnect between the water’s presence, its prohibited use, and the lengthy suspension of further construction has given the project national notoriety. In December 2019, the project earned a top spot on the Government Accountability Office’s (*Contraloría*) list of “Colombia’s White Elephants,” defined by a Colombian government monitoring delegate as “*obras de infraestructura desarrolladas con recursos públicos cuyos gastos superan los beneficios, algunas de ellas que quedaron abandonadas, con o sin terminar, y otras nunca fueron utilizadas para lo que fueron proyectadas*” (“Elefantes blancos,” 2020). The DRTT is one of three Colombian irrigation megaprojects (Table 1) marked by the government as “*suspendidos*.” Therefore, although the media represent the megaproject as abandoned, our research shows that the government continues to insist on the project’s future completion. Moreover, in contrast to unusable abandoned projects, the DRTT is being used by some, and the forms and relations of use are driving increasingly

differentiated access to environmental and social-economic resources, shifting patterns of cropping systems across the region and of the linked social conflict around governance systems for the district (see Baumann, 2022a).

The Colombian government attributes the suspension to a lack of government funds. An interview with a key government accountability official, however, suggests fiscal mismanagement and corruption. In a May 2021 interview the official said,

Con la segunda fase, es donde lo que se dio fue un proceso desbordado de corrupción. Un proceso tan desbordado que no es posible que desde el estado no se levantaran voces observando lo que estaba pasando, como tampoco fue nada observado por parte del órgano de control. Es decir, el saqueo se dio tan inmisericorde, sin que el estado observara nada. Ahí yo creo que hubo una decisión, de que eso se permitiera. . . . En el proceso de transición [en 2016, del proyecto de INCODER a la Agencia Nacional de Desarrollo]. . . yo creo que eso fue algo calculado, se perdió muchísima información que habría permitido reconstruir los hechos de corrupción y castigar los hechos de corrupción, pero mucha de esa información se perdió y entonces se hace casi que imposible hacer esa pesquisa para determinar todo lo que se perdió y sus responsables.

Whether there was corruption and a cover up by government agencies has been neither confirmed nor denied. What is true is that the government failed to assign the completion of the project to any agency following a

government restructuring in 2016. That year, the *Instituto Colombiano de Desarrollo Rural* (INCODER), previously responsible for the DRTT, dissolved into three agencies, one of which is the *Agencia de Desarrollo Rural* (ADR), now responsible for the technical maintenance of the DRTT.⁵ The agency is likewise responsible for the other suspended megaprojects in Colombia, paused in the same period (Table 1). Accountability for the execution of previously started infrastructure is unclear, however, between rural development agencies and the *Unidad de Planificación Rural Agropecuaria* (UPRA), established in 2011, whose explicit charge is to manage the *uso y adecuación de tierras* through the *construcción de infraestructura física para riego, drenaje o protección contra inundaciones* (UPRA). Neither UPRA nor any other government body has yet identified funding to complete the project or to define a regulatory system for the district.

Despite various diagnostics of the infrastructure by UPRA and other government agencies and declarations of the project as crucial to *estrategia nacional* (CONPES 2005, 2018), the government has not allocated funding or found financing to complete the DRTT. The *Contraloría* published a report in February 2020 that has since been removed from public access, estimating the cost of the project's completion at \$657 billion COP (approximately 168 million USD). In August 2021, the Duque administration committed \$3,823 million COP (approximately \$980,000 USD) for updated studies of design and a more exact budget projection of future costs, both of which were central goals to the previously posted call for proposals (*convocatoria*)

issued in January 2021 by Findeter, Colombia's actual Development Finance agency (Findeter, 2020).

Once the costs of completing the project are precisely defined alongside actualized engineering plans, the government intends to create a public-private partnership (PPP) to complete the remaining canals and administer the district. The ADR posted a call in August 2020 for an entity to manage the DRTT and two additional partially completed irrigation megaprojects, with a total budget of \$4,773,049,586 COP (\$1,228,205 USD). As of this writing, no decisions have been posted publicly. The creation of a PPP follows a growing trend across Latin America of PPP-funded infrastructure, driven by development bodies including the World Bank (Garcia-Kilroy & Rudolph, 2017) and the Banco de Desarrollo de América Latina (2017).

SUSPENSION DEEPENS SOCIAL-ENVIRONMENTAL AND POLITICAL-ECOLOGICAL UNEVENNESS IN ACCESS TO AND USE OF WATER AND LAND

Early development discourses around the DRTT claimed to address socio-economic disparities in a supposed post-conflict area with significant poverty and unemployment rates. A 2005 government agricultural planning document claimed the project would “*mejorar las condiciones de vida de una zona considerada deprimida pero con un alto potencial productivo*” (CONPES, 2005, p. 2). The government body previously responsible for the project, the INCODER, now the

Agencia Nacional de Tierras (ANT), later boasted the project was central to the goal of “*extender la frontera agrícola, en áreas en donde actualmente no se realiza ningún tipo de cultivo*” (INCODER, 2011, p. 6). The irrigation district would ideally better organize and utilize land considered underutilized by Colombia's land use planning agencies.

The language of economic depression and underutilization blurred the deeply entrenched socio-economic disparities in the region. The Colombian census of 2005, the most recent data processed nationally⁶ and in the year before construction for the DRTT started, indicated an Unsatisfied Basic Needs index of more than 71 percent in Coyaima (Alcalde de Coyaima, 2016, p. 17). In the same years, the residents were reeling after years of paramilitary occupation by the United Self-Defenses of Colombia (*Autodefensas Unidas de Colombia* or AUC), known for armed violence against local residents. While the documents analyzed in this research did not mention the years of conflict, the development of the DRTT would, according to government plans, create jobs for residents and improve the quality of life. As a previous mayor of Natagaima said in an interview in 2019, still hoping for the completion of the project, “[*El distrito*] *eso genera progreso, desarrollo, la economía se dispara, harto movimiento.*” Resident responses in household surveys and interviews overwhelmingly supported the presence of the infrastructure and hoped for its completion, with many citing the initial plan's design for bringing water to their own fields (Baumann, 2022a).

The suspension of the project's construction, however, exacerbated socio-envi-



Figure 3. Motor pump pulling water to irrigate rice field along a principal canal. Motor pumps, electricity, and fuel were costs inhibitive for some lower-income producers along the canals, contributing to disparities in who could use the water.



Figure 4. Irrigation canal created by land user channels water from principal canal to rice field. Such manually dug canals also required costly motor pump infrastructure and materials to pull water from the canals and direct a sufficient flow back to irrigate a rice paddy. Similar to Figure 3, this infrastructure, in addition to the costs of land access and rice production, indicated socio-economic advantages of the producer when compared to rural residents unable to access proximate land or infrastructure to use the canal water.

mental unevenness through increasing variations in water distribution, land access, cropping systems, and livelihoods (some aspects briefly noted in Table 4). With 10 percent of the canals constructed and inconstant water levels, water access was concentrated along the principal canals. Local producers noted one's field had to be within 300m of the canals to pump water into the field with motors and tubing (Figure 3). Other producers with land near enough to the water dug secondary canals (Figure 4). Water flows also increased along the rivers that served as the system's primary drainage channels. One producer that owned land along the Hilarco River added five additional hectares of paddy rice. While few to no producers had irrigation water before the project's suspension, now water access was concentrated in specific geographies.

Proximity to the canals or drainage channels did not guarantee, however, increased water use. Some producers near the canals could afford motorpumps and used them when there was no threat local authorities would forcibly remove them ("Autoridades se unen", 2019). However, others were unable to afford the necessary infrastructure. As one example, the first author visited one woman's home, located about 100 hundred yards from the reservoir. In geographic studies of canal irrigation systems, she would be considered a premier head-end irrigator, located along the start of Canal 1 (square in Figure 5). Despite her proximity to the reservoir and principal canal, she was unable to use the irrigation water. The woman, in her late 60s, lived alone among a cluster of homes belonging to her extended family and son. None of the

homes had plumbing. Across the canal, she cultivated a small (0.25-ha) field of plantains (*plátano cachaco*) for subsistence. Her only sources of income were the regular sales of chicha, a traditional fermented maize-based drink, and occasional sales of other home-made traditional foods. I asked if she pumped water from the canal for the plantains or for her home garden. No, she said, using canal water required the prohibitive costs of a motor pump, the fuel, and the electricity.

Her situation was indicative of broader trends among lower-income, diversified producers documented during interviews and farm walks. In a second example, a couple lived on a small lot along a canal. They had a 0.25-ha field of diversified vegetables and fruits, with over 25 varieties documented in the field walk, and a similarly sized field of plums. When asked, they noted they could not afford the infrastructure to pump the water out of the canal and route it to their fields. Instead, they took water from a well to fill a 1.5m³ tank from which to manually water crops when needed. Households far from canals or without the means to purchase and run a motor pump instead collected what water they could through harvesting from their roofs into tanks, relying on rain. Thus, proximity to irrigation channels does not ensure benefits from the infrastructure. Instead, overlapping unevenness in socio-economic resources and spatial location create inabilities to use irrigation water. These overlapping dynamics are illustrated in Figure 5, showing persons or communities along the principal canals that did not use the water, despite proximity, due to socio-economic or political disadvantages.

Similarly, the use of irrigation water, officially unauthorized, was also tied to social-political factors. Among the more than twenty Indigenous Pijao reservations (*resguardos*), at least three along the canals refused to withdraw water for agricultural production on their lands. Denoted by the stars in Figure 4, the communities had decided to prohibit the use of the irrigation water. When interviewed, community leaders discussed their desire to see the water used for certain types of agrobiodiverse production systems (see Baumann, 2022a), but the leaders were also straightforward in their reasoning. “*Está prohibido el uso del agua. El distrito no está en operación*,” shrugged one leader. The communities resided in their government-granted land and received government support contingent on certain land use agreements. Unauthorized use of the irrigation water could put their standing at risk or draw unwelcome oversight. Instead of depending on the irrigation system, two won grants for alternative agricultural water management investments. One established a silvopastoral system with thousands of trees in a once-arid stretch of their land. A second found funding for a solar-powered motorpump to draw water from the nearby river. Conversations with community leaders suggested water use was also mediated by political power and influence, generally limited for Indigenous communities.

In addition to socio-economic and social-political barriers, use of irrigation water was mediated by access to proximate land. The land around the canals and rivers doubled in rental value between late 2014 and 2018. Residents reported a doubling of land

rental prices from 500,000 COP to 1,000,000 COP (\$125 to \$300 USD) per hectare per semester for land along the principal canals or rivers, with strengthened flows from canal drainage. Many low-income producers were unable to pay such prices and were thus excluded from water use. The first author interviewed two large-scale rice producers from neighboring districts (Baumann, 2022b) that had recently started renting in the DRTT. “*Los suelos son virgenes*,” one commented, referencing the nutrient density in soils that had never produced rice, “*Tuve cosechas muy buenas y ningún problema de malezas*.” The second said, “*El costo de producción es mucho mejor que en los distritos al norte porque no hay tarifa de agua y los arriendos son más económicos*.” While local, low-income, small-scale producers were unable to pay increasing land rents, larger-scale producers with more assets used the project’s suspension to earn higher profits.

The social-environmental disparities in access to and use of water and land combined with differences in social and socio-economic capital to drive uneven changes in cropping systems. The water distribution enabled a sharp increase in hectares under paddy rice production, from fewer than 700 ha to approximately 2,000 ha (Figure 6), with all rice fields concentrated along the canals and rivers. In addition to the water enabling rice production, the producers of paddy rice experienced harvest numbers unheard of in neighboring districts, including up to 14 tons per hectare, or 280 *bultos* (bulto = 50 kilos) (data from Colombia’s agronet.gov.co). For comparison, other rice-producing areas nearby aspired

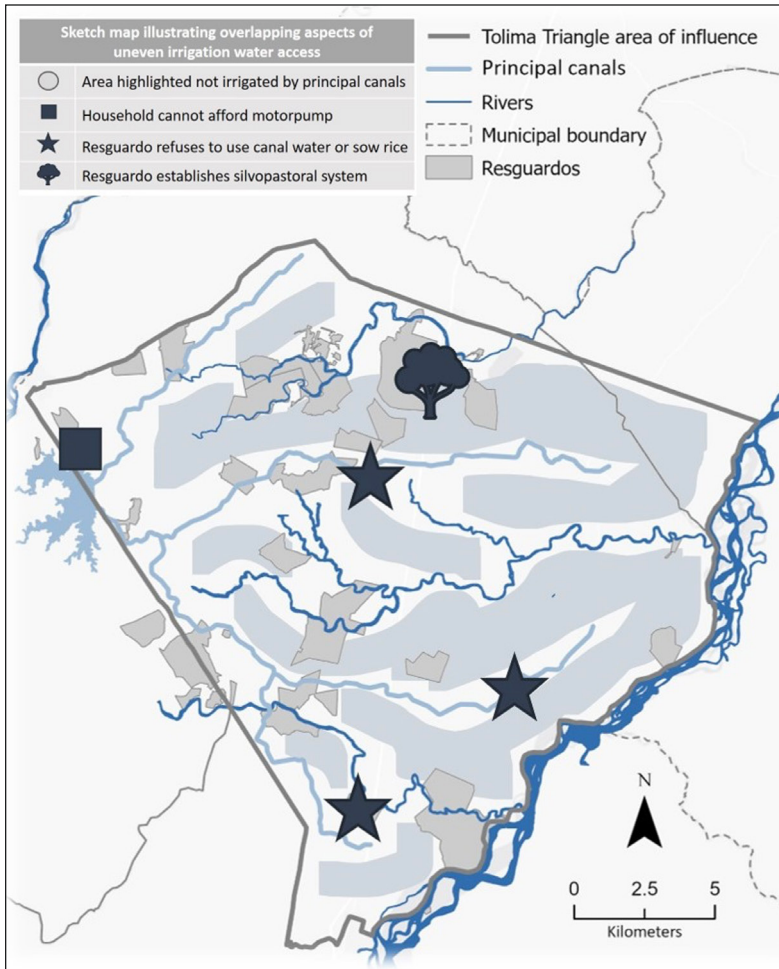


Figure 5. Sketch map and associated legend illustrating a selection of examples of overlapping unevenness in access to irrigation water. For example, even the location of a head-end irrigator does not ensure the use of water but overlaps with socio-economic disparities or community resource use decisions regarding the use of canal water. Gray highlighting indicates areas too far from principal canals to use water.

to harvest 120 *bultos* per hectare (Baumann, 2022b). Yet making earnings from paddy rice production required expertise in rice cultivation, significant machinery, social capital to interact with local mills and buyers, and economic capital to prepare fields, pay day laborers, and invest in seeds and agrochemicals. Low-income residents, whom the district was intended to benefit according to government discourse, generally did not possess the necessary social, knowledge, and financial capital to produce paddy rice at all, much less at such immensely

profitable scales. A lifetime resident of the DRTT described the situation as “*Sálvese quien pueda. El que tiene más saliva moja más pan.*” (Figuratively, the saying means something like “Every man for himself. He who has more resources and takes advantage of opportunities is better off in the end.”) The project’s suspension aggravated disparities in access to and use of water and land, resulting in new patterns of cropping systems and linked uneven profits.

LINKAGES OF SUSPENDED INFRASTRUCTURE, CONTESTATION,
AND SOCIAL-ENVIRONMENTAL UNEVENNESS

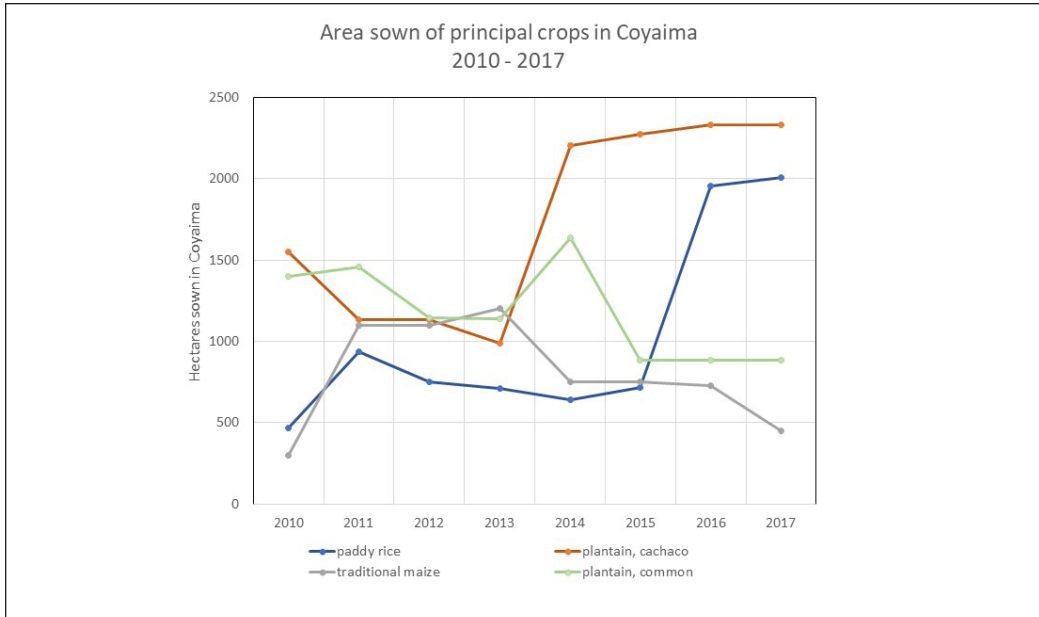


Figure 6. Graph of area sown of principal crops in Coyaima from 2010-2017. Note blue line of sharp increase in paddy rice production following 2015. (Data for full years was only available through 2017 at the time of writing this article. For this reason, 2018 is not included in Figures 6 and 7.)

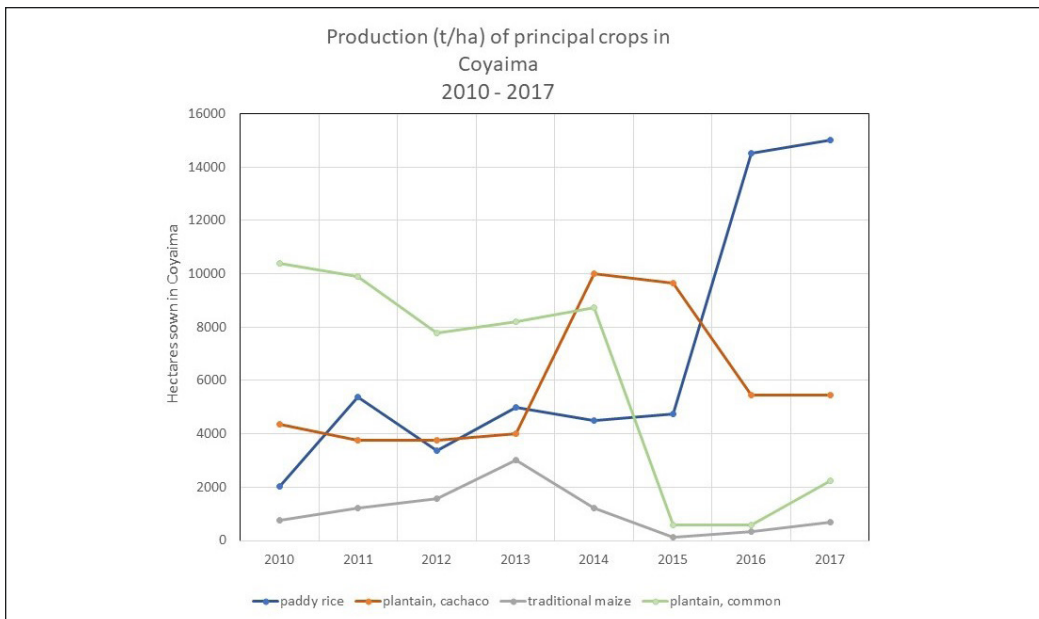


Figure 7. Graph of total production (t/ha) in Coyaima of principal crops in Coyaima from 2010-2017. Note blue line of sharp increase in paddy rice production following 2015.

CONTESTATION: IRRIGATION DEMANDS AND GOVERNMENT STRATEGY

While the project's delay made national news, local and regional contestations intensified as residents observed uneven gains from the unauthorized use of the water. Low-level social tension regarding the project's suspension simmered in conversations across social groups and spaces. Importantly, rice production had, for many residents, become a proxy for anger about uneven gains tied to the project's partial completion (see Baumann, 2022a). During the first author's initial trip to the DRTT in December 2017, one *resguardo* president revealed in an interview that he had placed sanctions on a member for renting to a rice producer. In quotidian conversations, small-scale producers spoke poorly of those who cleared land for rice or offered rental contracts in cash to peasant farmers along the canals. In October 2018, the first author sat in the local radio production room, listening to a leader of the proposed water user association Utritól insist that the government complete the district intended "*para los residentes! ¡Para cultivar comida para nuestras familias! ¡No para el arroz!*"

Later that month, water levels in the canals reached extreme lows. Immediately, the area's producers organized to protest, believing the ADR had closed the sluice-gates. At six in the morning that Thursday, approximately 200 people met north of Natagaima to close Highway 45, the principal and only route to the department's capital city of Ibagué and to Bogotá. Despite the months of local conflicts between residents

regarding cropping systems and uneven use of water, all had organized together on the highway. Wealthier rice producers had driven large tractors to park across the highway. Small-scale diversified producers had arrived in a *chiva*, a large bus designed for mountain or rural unpaved roads. The first author asked a small-scale Pijao producer what her demands were; she said, "*Se secó la quebrada. Reclamamos el agua el las quebradas.*" Although she lived too far to use canal water, she and her neighbors needed the drainage water for hauling to their fields or for washing clothes. Another small-scale producer with one-hectare of diversified crops exclaimed, "*Estoy aquí para exigirles que terminen esta obra!*" By ten o'clock that morning, the head of the ADR and staff had arrived at the blockade to encourage protestors to open the highway. The ADR insisted the producers themselves had overdrawn the water, causing the low levels.

Water levels aside, the smaller-scale producers demanded the ADR demonstrate advances towards the district's completion. The rice producers, generally with more social-economic and political power, demanded the ADR negotiate with them on the established minimum levels of water. Late October was near the end of the rice season and the fields needed to be constantly flooded, requiring more water. The ADR committed to filling the canals the next day, and to a meeting with the rice producers the following week. Almost four years after the project's suspension, the smallholders continued hoping for the completion of secondary, tertiary, and inter-field canals so they, too, could have irrigation water; however,

Category	Descriptor of unevenness	Source	Suspension further contributes to unevenness
Environmental	Cropping systems, uneven patterns of land use	Irrigation canals contribute to intensified production of paddy rice along canals and drainage channels.	Yes. Without an administrative unit for the irrigation water, there is no tariff structure or governance over cropping choice.
Environmental	Irrigation water distribution	Four principal canals	Yes. Irrigation water access concentrated to built canals instead of distributed widely, according to original project plans. Strong water flows are now present but channeled, making their use exclusive.
Social	Socio-economic and other capital in agricultural livelihoods	Residents with more socio-economic resources are able to rent land with water access and/or afford inputs for paddy rice or cotton, which have higher prices in markets.	Yes. With a constrained supply of irrigated land and no formal governance of water use, unevenness intensifies in terms of marginalized smallholders and larger agribusiness producers. Moreover, low-income households are unable to afford motor pumps and gasoline to pump out irrigation water.
Social	Size and tenure of landholdings (own, rent, adjudicated)	Historic land consolidation. Adjudicated land to Indigenous resguardo communities since 1991.	Yes. Land rental prices double for fields along canals and drainage channels.
Social-environmental and political-ecological	Resource governance rules and policies: Regional, municipal, 22+ Indigenous governments	Indigenous resguardo governments have general autonomy to establish cropping system regulations that may differ from municipal and regional regulations. Similarly, they must negotiate political power differences in accessing and using irrigation water.	With no regulation of water use to direct legal water withdrawals, some Indigenous resguardos opt not use the canal water. This impacts production as it limits growers to rain-fed crops.

Table 4. Descriptors of social and environmental unevenness related to suspension.

they lacked the socio-economic and therefore political power to appeal directly to the government officials.

The same government officials dismissed contestations around the project's suspension and unevenly experienced benefits as a social problem. In the 2018 CONPES, an

official rural planning document, the ADR warned that the project's completion may be further delayed due to social issues:

Si la gestión social con comunidades étnicas y grupos de productores no se lleva a cabo de manera planificada y asistida con

las entidades competentes para tal fin, se pueden retrasar los proyectos y afectar las proyecciones iniciales en la estructuración, como ha sido el caso en el proyecto de Triángulo del Tolima. (p. 26)

The agency pointed to the social conflicts among potential beneficiaries as a potential obstacle to the project's completion.

When interviewed in February 2019, months after the highway protest, the leading ADR official repeated the same warning of social barriers to the infrastructure's success, this time with more pointed remarks about the lack of interest among Indigenous persons in developing an entrepreneurial mentality:

El Triángulo tiene una particularidad [entre otros distritos de riego] y es que la mayoría de los usuarios son comunidades indígenas, una cultura que mentalmente no tiene la disposición de producir con línea empresarial sino solamente auto-consumo y de subsistencia. . . . La gran dificultad que tiene el proyecto, porque técnicamente si es un excelente proyecto, es de pronto la parte cultural, el tipo de usuarios que supuestamente tiene que empezar a desarrollarse dentro del área del proyecto.

The ADR summarized the principal problem of the DRTT not as its partial construction or worsening disparities in resource access, but as an inadequate cultural disposition of Indigenous residents to cultivate for markets. In a sweeping discriminatory generalization, the official ignored both the histor-

ical social-environmental inequities of the region and the almost five-year delay. When pressed to respond to the inaction of the government, the person repeated the ADR's stance: "*Nosotros [la ADR] no tomamos las decisiones. . . Las políticas del gobierno nacional define el presupuesto.*" The Duque administration, in office at the time of this article's submission, has not since set a budget for the yet-unanswered call for a private company to join the government in a PPP.

The contestations continued among producers and sustained the attention of various regional actors. In May 2019, the Contraloría partnered with agronomists from Agrosavía, the agricultural investigative center tied to the government, to host a facilitated listening session with DRTT producers. More than 40 residents attended the meeting in Coyaima, including at least seven large-scale rice producers and twenty small-scale producers. The agronomists argued the soils in the district were too fragile for paddy rice production, and the irrigation system was not built to sustain water flows necessary for flooding fields for weeks at a time. A Bogotá-based NGO with a local office sent a letter criticizing the government's lack of action to complete the project and ensure the sustainable use of the water, emphasizing that "*el uso del suelo, la función ecológica y social de la propiedad, el uso racional del agua, el mejoramiento de la productividad agropecuaria y el bienestar de las comunidades y el aporte al desarrollo de Colombia se han contravenido completamente*" (first author's archives). The meeting ended with producers shouting over one another about their conflicting views. In an early 2021 conversation, the Contraloría

representative present that day said, “*Yo no veo esa [alianza pública privada porque] yo no veo ese privado metiéndose en un escenario de tal complejidad social.*” Government agencies characterized the district by the ongoing social contestation over the access to and use of water and land, meanwhile taking no actionable steps towards completing the infrastructure.

Simultaneously, as various regional government entities attended to the demands from rice producers and non-rice producers alike that the project’s construction continue, other agencies were reallocating irrigation investments and asking producers in neighboring irrigation districts to decrease their production of rice for domestic markets. In a meeting of irrigation districts and the Ministry of Agriculture in February 2019, the Ministry announced a shift in strategy to no longer initiate or fund new irrigation infrastructure, but instead to finance the expansion or improvement of already successful districts. Districts’ management were to apply for funds through an online portal. No mention was made of the implications for the partially completed irrigation megaprojects, including the DRTT.

Three months later, in May 2019, during participant observation in the offices of an irrigation district to the north, rumors circulated that a government official had asked the district’s general manager to cap the number of hectares sown in rice for the upcoming season. Rice was the district’s principal crop and therefore the central source of income for thousands of producers (Baumann, 2022b). The general manager refused. The government’s strategy was later made public

(“Techo de cosecha de arroz”, 2019). Under free trade agreements, importing rice was significantly cheaper than supporting Colombian rice producers, a policy heatedly discussed among farmers. Related currents of citizen and producer dissatisfaction spurred widespread protests across the region and country in 2019.

DISCUSSION: ADVANCING A COMBINED SOCIAL- ENVIRONMENTAL AND POLITICAL-ECOLOGICAL PERSPECTIVE ON SUSPENDED INFRASTRUCTURE

The linkages between suspension, social-environmental unevenness, and contestation of infrastructures are deserving of research attention. This research makes three contributions to related literatures and the concepts of infrastructure, suspension, and contestation, and it expands our understanding of Colombia’s priorities for future irrigation infrastructure.

First, through an integrated political ecology and social-environmental systems framework, our research advances research and scholarship on infrastructure geographies by showing that the development of infrastructure, including suspensions or delays, is a combined social-environmental and political-ecological process with imprints on the landscape through shifts in water distribution, land use, and cropping systems (Carse, 2014; Zimmerer et al., 2022). The case of the Tolima Triangle demonstrates that suspended infrastructures have social and environmental consequences for local resource users. The

original plans for the district would reach 7,500 families with the goal of strengthening the livelihoods of 19,000 residents. Yet the channeling of water concentrated access to water's benefits, mediated by costs of land rentals or ownership.

Second, the water use for intensive rice and cotton cropping benefits those with more economic resources, while other residents without land access or the means by which to pull water continue to struggle to produce in the arid landscape. Therefore, as the second main contribution, this study's analysis of the case of the Tolima Triangle builds on suspension and infrastructure debates by illustrating how suspended projects are not neutral pauses in the process of suspended infrastructure but can widen social-environmental disparities in access to and use of land and water resources.

And third, by analyzing contestation's relationships to unevenness and suspension, we contend that contestations around an infrastructure function to make claims on the government to fulfill its promises, and hold the government accountable for its prior plans. Infrastructure scholars have argued that many infrastructures aim to be invisible,⁷ but their dysfunction or abandonment make them visible (Star & Ruhleder, 1996; Harvey, 2018). In the case of the Tolima Triangle, the contestations by communities and other residents directed at the widening gaps in resource use, the project's partial completeness, and the government's suspension of investments combine to keep the project visible before the public and the government. Their ongoing contestation of this suspended infrastructure is designed to ensure that the

government does not abandon it or change the planned design for beneficiaries.

Pushing forward more regional and Colombia-specific research, inquiry into contestations reveals more than a simple social protest against a project or an additional cause of project delay. Rather, analyzing the contestations in Tolima reveals historic and ongoing patterns of unevenness, their intersections with government policies, and citizen's ongoing claims on the state. In the case of the Tolima Triangle, some government agencies framed smallholder contestations of the project's suspension and water use as an ethno-racialized issue of Indigenous groups. The government agency's ethno-racialized discourses regarding Indigenous beneficiaries of the project suggest continued structural discrimination potentially aggravating disparities in access to natural resources and political power, thus illustrating the 'vital' (Correia, 2020) nature of such projects both in terms of necessity for livelihoods and ethno-racialized structural processes. The dismissal of Indigenous beneficiaries as incapable works to the advantage of the government by shifting responsibility onto potential users. By placing the blame on Indigenous peoples' supposed lack of entrepreneurial efforts and on social contestations for a lack of water use regulation and project success, the government moves attention away from allegations of fiscal irresponsibility and poor project oversight during the 2015 government restructuring.

The absence of government follow-through on the project accompanies the Colombian government's political-economic shifts in irrigation investments and domes-

tic agricultural production. As the Ministry of Agriculture tells district administrations there will be no funding to build new irrigation districts, other government officials limit the production of rice to balance cheaper imports. While no direct statements have been made explaining the DRTT suspension, it may serve the government's strategy to limit national grain production. The duration of the megaproject's development has spanned political administrations and related agricultural policy shifts, with potential consequences for the completion of a project initially intended to expand Colombia's agricultural frontier. Taken together, the lack of government funding to complete the megaproject, the publicly expressed shifting of irrigation strategies, and the simultaneous de-emphasis on domestic rice production suggests a marked pivot in the political economy of Colombia's irrigation infrastructure vision away from megaprojects and towards expansion or improvement of smaller systems.

Finally, the Tolima Triangle's contested and ongoing suspension may mark a change in the financialization of water infrastructures in Latin America (Furlong, 2020a). Although public-private partnerships (PPP) have been key in the financing of large-scale infrastructure for roads, transportation, electricity, and other utilities, few water infrastructures and specifically irrigation projects have been funded by PPPs in Latin America (Watkins et al., 2017). The Tolima Triangle, first designed in the 1990s, bridges the eras of the Concrete Revolution and the rise of PPPs (Sneddon, 2015). Colombia's continued search for a private entity to complete and administer the

DRTT and the other two stalled irrigation megaprojects gestures toward heightened interest in privately funded irrigation infrastructure. Private financing of irrigation systems can further exclude smallholder producers, as financial pressures related to water tariffs and increasing land values result in new forms of land control, including contract or outgrower arrangements (Hall et al., 2017; Baumann, 2022b).

CONCLUSIONS

In expanding focus on infrastructure delays, suspensions, and contestations, scholars and policymakers are generating insight into the socially-environmentally uneven ways in which infrastructures unfold, including as mechanisms through which unevenness may worsen. This study advances specialized scholarship on infrastructure geographies and offers general insights for those investigating infrastructure in Colombia and Latin America more broadly, in particular shifting strategies in financing infrastructure and the rise of public-private partnerships in rural hydraulic infrastructure development across the region.

Theoretically, our research integrates social-ecological systems and political ecology frameworks to analyze how suspended infrastructure construction may lead to deepening disparities in resource access. We integrate the worsening social-environmental and political-ecological unevenness with contestation to emphasize that residents are at once both protesting differentiated benefits and demanding the government complete the project. By examining the linkages of

these dynamics, our research pushes forward scholarship on infrastructure's suspension as future-oriented while also demonstrating the immediate social-environmental impacts on the landscape and communities.

This study's case study of the irrigation megaproject of Colombia's Tolima Triangle opens new pathways for investigation. The research makes evident the need for governance of land access and tenure in the planning of irrigation infrastructure. As

development financiers around the globe fund extensions to existing irrigation infrastructures or new projects, communities and governments must work with expanded understanding of the land-water connections determinant of water use and availability. Additional pathways of investigation include narrowed focus on the political economies of states tied to suspended infrastructure projects and the social-environmental changes spurred by such politicized delays.

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CONTRIBUTIONS

Megan Dwyer Baumann: Research design, data collection, analysis, conceptualization, writing, editing, revisions, administrative tasks.

Karl S. Zimmerer: Consultation on research design in early stages, conceptualization, editing, revisions.

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DISCLOSURE STATEMENT

There are no conflicts of interest.

NOTES

- 1 The original impetus for the megaproject is unclear. Local residents claim that the government responded to their demands from the 1970s onward. Government documents available from the early 2000s state that the project will bring social benefits through irrigation but do not refer to community engagement.
- 2 A note on terminology: In the manuscript, the DRTT refers to the region of research or a spatial extent as well as an infrastructural project. The use should be clear when in context.
- 3 This research was undertaken following the approval by the [University] Human Research Protection Program, or Institutional Review Board (IRB), of all interview guides, survey instruments, and data storage and management plans. Personal identifiable information was stored securely on paper surveys in the first author's secure data storage and was never transferred to digital formats.
- 4 The full titles of the water user associations are: Asociación de Usuarios del Distrito de Adecuación de Tierra de los Ríos Coello y Cucuana (Usocoello) and Asociación de Usuarios del Distrito de Adecuación de Tierras de Gran Escala del Río Saldaña (Usosaldaña).
- 5 For more details on administration changes and rural development, see *Peace and Rural Development in Colombia* by Andrés García Trujillo (2020).
- 6 The 2018 census data was not fully analyzed in terms of poverty indices at the writing of this article.
- 7 While certainly others aim for spectacle (Schwenkel, 2015).
- 8 Sources include: BNamericas (24 Jun. 2022), "Ejecución de las Líneas 3 y 4 del Metro del Lima vía obra pública o gobierno a gobierno no es viable financieramente," <https://www.bnamericas.com/es/noticias>; Camargo, P. (2015), *A Ferrovia Nova Transnordestina em meio às atuais condições de reprodução camponesa em Ouricuri (sertão pernambucano)* (Doctoral dissertation, Universidade de São Paulo); Goy, L. (15 Dec. 2016), "Railway to nowhere shows Brazil's infrastructure woes," *Reuters*, available at www.reuters.com; Zavala, J.C. (16 Apr. 2018), "Contraloría indaga irregularidades en obras de la presa Paso Ancho, Oaxaca," *El Universal*, available at www.oaxaca.eluniversal.com.mx. For Colombian projects, the source is: Ministerio de Agricultura y Desarrollo Rural (2020), Resolución número 000311 de 2020: Por la cual se adopta el Plan Nacional de Riego 2020-2039," p. 31, available at www.minagricultura.gov.co/. Exchange rate average for 2021 (.3832) used for estimates.

REFERENCES

- Agencia de Desarrollo Rural (ADR). (2020, September). Especificaciones y Requisitos Técnicos Mínimos. [Reportaje]. "Especificaciones y requisitos técnicos mínimos: Revisión y actualización estudios y diseños para la terminación del proyecto estratégico de Adecuación de Tierras de Gran Escala del Triángulo del Tolima." Available at www.findeter.gov.co/system/files/convocatorias/PAF-ADR-I-064-2020/AnexoEspecificacionestecnicas.pdf

- Alcalde de Coyaima. (2016). *Diagnostico Situacional de la infancia, adolescencia y juventud en el municipio de Coyaima Tolima*. Coyaima. <http://www.coyaima-tolima.gov.co/Transparencia/>
- Akbulut, B., Adaman, F., & Arsel, M. (2018). Troubled waters of hegemony: Consent and contestation in Turkey's hydropower landscapes. In F. Menga & E. Swyngedouw (Eds.), *Water, technology and the nation-state* (pp. 96-114). Routledge.
- Appel, H. C. (2012). Walls and white elephants: Oil extraction, responsibility, and infrastructural violence in Equatorial Guinea. *Ethnography*, 13(4), 439–465. <https://doi.org/10.1177/1466138111435741>
- Appel, H. C., Anand, N., & Gupta, A. (Eds.). (2018). Introduction: Temporality, politics, and the promise of infrastructure. In *The promise of infrastructure* (Vol. 9, pp. 1–38). Duke University Press. <https://doi.org/10.1215/9781478002031>
- Atkins, E., & Hope, J. (2021). Contemporary political ecologies of hydropower: insights from Bolivia and Brazil. *Journal of Political Ecology* 28(1), 246-265. <https://doi.org/10.2458/JPE.2363>
- Attwood, D. W. (1987). Irrigation and imperialism: The causes and consequences of a shift from subsistence to cash cropping. *The Journal of Development Studies*, 23(3), 341–366. <https://doi.org/10.1080/00220388708422037>
- Autoridades se unen por la recuperación del Triángulo del Tolima. (2019, August 3). *Ondas de Ibagué*. Retrieved from <https://www.ondasdeibague.com/noticias/>
- Baird, I. G. (2017). Resistance and contingent contestations to large-scale land concessions in southern Laos and northeastern Cambodia. *Land*, 6(1). <https://doi.org/10.3390/land6010016>
- Bancalari, A. (2020). Can white elephants kill? Unintended consequences of infrastructure development in Peru [Working Paper]. <https://ifs.org.uk/publications/>
- Banco de Desarrollo de América Latina. (2017, June 23). Ventajas de las APP para el sector del agua en América Latina. Retrieved from <https://www.caf.com/es/conocimiento/visiones/2017/06/ventajas-de-las-app-para-el-sector-del-agua-en-america-latina/>

- Barnes, J. (2017). States of maintenance: Power, politics, and Egypt's irrigation infrastructure. *Environment and Planning D: Society and Space*, 35(1), 146–164. <https://doi.org/10.1177/0263775816655161>
- Baumann, M. D. (2022a). Agrobiodiversity's caring material practices as a symbolic frame for environmental governance in Colombia's southern Tolima. *Geoforum*, 128, 286–299. <https://doi.org/10.1016/j.geoforum.2021.01.002>
- Baumann, M. D. (2022b). Baumann, M. D. (2022b). Examining land rental markets' linkages to land and water control in Colombia's irrigation megaprojects: integrating the political economy of agrarian change and the political ecology of vulnerability. *The Journal of Peasant Studies*, 1–27. <https://doi.org/10.1080/03066150.2022.2082961>
- Baumann, M. D. (2022c). Living a callejera methodology: Grounding María Lugones' streetwalker theorizing in feminist decolonial praxis. *Gender, Place & Culture*. <https://doi.org/10.1080/0966369X.2022.2081133>
- Bebbington, A., Chicchon, A., Cuba, N., Greenspan, E., Hecht, S., Humphreys Bebbington, D., Kandel, S., Osborne, T., Ray, R., Rogan, J., & Sauls, L. (2020). Priorities for governing large-scale infrastructure in the tropics. *PNAS*, 117(36), 21829–21833. <https://doi.org/10.1073/pnas.2015636117>
- Bebbington, D. H., Verdum, R., Gamboa, C., & Bebbington, A. J. (2018). Special collection: Mega-projects, contentious action, and policy change in Latin America conflicts over extractivist policy and the forest frontier in Central America. *European Review of Latin American and Caribbean Studies*, 106(106), 103–132. <https://doi.org/http://doi.org/10.32992/erlacs.10414>
- Birkenholtz, T. (2009). Irrigated landscapes, produced scarcity, and adaptive social institutions in Rajasthan, India. *Annals of the Association of American Geographers*, 99(1), 118–137. <https://doi.org/10.1080/00045600802459093>
- Birkenholtz, T. (2013). “On the network, off the map”: Developing intervillage and intragender differentiation in rural water supply. *Environment and Planning D: Society and Space*, 31(2), 354–371. <https://doi.org/10.1068/d11510>
- Birkenholtz, T. (2022). Infrastructuring drip irrigation: The gendered assembly of farmers, laborers and state subsidy programs. *Environment and Planning E: Nature and Space*. <https://doi.org/10.1177%2F25148486221100386>

- Boelens, R., Hoogesteger, J., Swyngedouw, E., & Wester, P. (2017). Hydrosocial territories: A political ecology perspective. *Water International*, 41, 1–14. <https://doi.org/10.1080/02508060.2016.1134898>
- Bresnihan, P., & Hesse, A. (2020). Political ecologies of infrastructural and intestinal decay. *Environment and Planning E: Nature and Space*, 251484862090238. <https://doi.org/10.1177/2514848620902382>
- Carney, J. A. (1991). Indigenous soil and water management in Senegambian rice farming systems. *Agriculture and Human Values*, 8(1–2), 37–48. <https://doi.org/10.1007/BF01579655>
- Carney, J. A. (1993). Converting the wetlands, engendering the environment: The intersection of gender with agrarian change in the Gambia. *Economic Geography*, 69(4), 329–348. <https://doi.org/10.2307/143593>
- Carse, A. (2014). *Beyond the big ditch: Politics, ecology, and infrastructure at the Panama Canal*. The MIT Press. <https://doi.org/10.7551/mitpress/9780262028110.001.0001>
- Carse, A., & Lewis, J. A. (2017). Toward a political ecology of infrastructure standards: Or, how to think about ships, waterways, sediment, and communities together. *Environment and Planning A*, 49(1), 9–28. <https://doi.org/10.1177/0308518X16663015>
- Carse, A. & Kneas, D. (2019). Unbuilt and unfinished: The temporalities of infrastructure. *Environment and Society*, 10(1), 9–28. <https://doi.org/10.3167/ares.2019.100102>
- Chambers, R. (1988). *Managing canal irrigation: practical analysis from South Asia*. University of Cambridge Press. <https://doi.org/10.2307/635352>
- CM&. (2019, December 19). Absolutamente inaudita la cifra que revela la Contraloría sobre elefantes blancos en el país. *CM& Colombia*. <https://noticias.canal1.com.co/uno-dos-tres/napa-cuatro-absolutamente-inaudita-la-cifra-que-revela-la-contraloria-sobre-elefantes-blancos-en-el-pais/>
- CONPES. (2018, May 23). *Política de adecuación de tierras 2018-2023*. No. 3926. Departamento Nacional de Planeación. Bogotá.
- CONPES. (2005, June 13). Autorización a la nación para contratar un empréstito externo con el gobierno de España hasta por us\$ 146 millones, o su equivalente en otras monedas,

con el fin de financiar parcialmente el proyecto “construcción del distrito de riego triángulo del tolima”; así como declarar su importancia estratégica nacional. No. 3357. Departamento Nacional de Planeación. Bogotá. <https://colaboracion.dnp.gov.co/CDT/Conpes/Econ%C3%B3micos/3357.pdf>

Correia, J. E. (2019). Arrested infrastructure: Roadwork, rights, racialized geographies. *Roadsides*, 2, 14–24. <https://doi.org/10.26034/roadsides-20190023>

Correia, J. E. (2020). Vital infrastructure: Rethinking relationships between race and environmental geographies in Latin America’s fading forests. In *Annual Meeting of American Association of Geographers*.

Cousins, J. J. (2019). Malleable infrastructures: Crisis and the engineering of political ecologies in Southern California. *Environment and Planning E: Nature and Space*, 3(2), 251484861989320. <https://doi.org/10.1177/2514848619893208>

CRIT, Autoridades Tradicionales del Consejo Regional Indígena del Tolima. (2020). Resguardos Indígenas. Accessed on 26 Feb. 2020. <https://crit.com.co/resguardos-indigenas/>

Damonte, G., Ulloa, A., Quiroga, C., & López, A. (2022). La apuesta por la infraestructura: Inversión pública y la reproducción de la escasez hídrica en contextos de gran minería en Perú y Colombia. *Estudios atacameños*, 68. <http://dx.doi.org/10.22199/issn.0718-1043-2022-0002>

Delgado, J. V., & Zwartveen, M. (2008). Local/global encounters modernity, exclusion and resistance: Water and indigenous struggles in Peru. *Development*, 51, 114–120. <https://doi.org/10.1057/palgrave.development.1100467>

Duarte-Abadía, B., Boelens, R. & Roa-Avendaño, T. (2015). Hydropower and the (re)patterning of hydrosocial territories. *Human Organization* 74(3), 243–54. http://www.cedla.uva.nl/20_research/pdf/Boelens/DuarteBoelensRoaHydrosocialTerritorySogamosoHumOrg2015.pdf.

Duarte-Abadía, B., & Boelens, R. (2016). Disputes over territorial boundaries and diverging valuation languages: the Santurban hydrosocial highlands territory in Colombia. *Water International*, 41(1), 15–36. <https://doi.org/10.1080/02508060.2016.1117271>

- El Concejo Municipal de Coyaima. (2016). *Acuerdo Nro. 008 DE 2016*. Coyaima. https://hospital-san-roque.micolombiadigital.gov.co/sites/hospital-san-roque/content/files/000001/24_plan-de-desarrollo-ahora-si-coyaima-un-gobierno-para-todos-2016--2019.pdf
- El DANE reveló cifras del censo en los 47 municipios del Tolima (2019, July 11), *El Cronista*. Retrieved from <https://www.elcronista.co/>
- “Elefantes blancos” en Colombia cuestan \$25 billones (2020, September 9), *El Espectador*. Retrieved from <https://www.elespectador.com/economia>
- Findeter. (2020). Propuesta Económica. PAF-ADR-C-027-2020.
- Furlong, K. (2014). STS beyond the “modern infrastructure ideal”: Extending theory by engaging with infrastructure challenges in the South. *Technology in Society*, 38, 139–147. <https://doi.org/10.1016/j.techsoc.2014.04.001>
- Furlong, K. (2020a). Geographies of infrastructure 1: Economies. *Progress in Human Geography*, 44(3), 572–582. <https://doi.org/10.1177/0309132519850913>
- Furlong, K. (2020b). Geographies of infrastructure II: Concrete, cloud and layered (in) visibilities. *Progress in Human Geography*. <https://doi.org/10.1177/0309132520923098>
- Garcia-Kilroy, C., & Rudolph, H. P. (2017). *Private Financing of Public Infrastructure through PPPs in Latin America and the Caribbean*. The World Bank Group. Washington, D.C. <https://www.worldbank.org>
- Guma, P. K. (2020). Incompleteness of urban infrastructures in transition: Scenarios from the mobile age in Nairobi. *Social Studies of Science*, 50(5), 728–750. <https://doi.org/10.1177/0306312720927088>
- Gupta, A. (2018). The future in ruins: Thoughts on the temporality of infrastructure. In N. Anand, A. Gupta, & H. C. Appel (Eds.), *The Promise of Infrastructure* (pp. 62–79). Duke University Press.
- Gutierrez, G. M., Kelly, S., Cousins, J. J., & Sneddon, C. (2019). What makes a megaproject? A review of global hydropower assemblages. *Environment and Society: Advances in Research*, 10(1), 101–121. <https://doi.org/10.3167/ares.2019.100107>

- Hall, R., Scoones, I., & Tsikata, D. (2017). Plantations, outgrowers and commercial farming in Africa: agricultural commercialisation and implications for agrarian change. *Journal of Peasant Studies*, 44(3), 515–537. <https://doi.org/10.1080/03066150.2016.1263187>
- Harris, L. M. (2008). Water rich, resource poor: Intersections of gender, poverty, and vulnerability in newly irrigated areas of southeastern Turkey. *World Development*, 36(12), 2643–2662. <https://doi.org/10.1016/j.worlddev.2008.03.004>
- Harvey, P. (2018). Infrastructures in and out of time: The promise of roads in contemporary Peru. In N. Anand, A. Gupta, & H. C. Appel (Eds.), *The promise of infrastructure* (pp. 80–101). Duke University Press. <https://doi.org/https://doi.org/10.1515/9781478002031-005>.
- Hetherington, K. (2016). Surveying the future perfect: Anthropology, development and the promise of infrastructure. In P. Harvey, C.B. Jensen, & A. Morita (Eds.), *Infrastructures and social complexity: A companion* (pp. 40–50). Routledge.
- Hetherington, K. (Ed.) (2018). *Infrastructure, environment, and life in the Anthropocene*. Duke University Press.
- Hidalgo-Bastidas, J. P., Boelens, R., & Isch, E. (2018). Hydroterritorial configuration and confrontation: The daule-peripa multipurpose hydraulic scheme in coastal Ecuador. *Latin American Research Review*, 53(3), 517–534. <https://doi.org/10.25222/larr.362>
- Hommes, L., Boelens, R., & Maat, H. (2016). Contested hydrosocial territories and disputed water governance: Struggles and competing claims over the Ilisu Dam development in southeastern Turkey. *Geoforum*, 71, 9–20. <https://doi.org/10.1016/j.geoforum.2016.02.015>
- Hope, J. (2022). Driving development in the Amazon: Extending infrastructural citizenship with political ecology in Bolivia. *Environment and Planning E: Nature and Space*, 5 (2), 520–542. <https://doi.org/10.2458/JPE.2363>
- Howe, C., Lockrem, J., Appel, H. C., Hackett, E., Boyer, D., Hall, R., Schneider-Mayerson, M., Pope, A., Gupta, A., Rodwell, E., Ballestero, A., Durbin, T., el-Dahdah, F., Long, E., & Mody, C. (2016). Paradoxical infrastructures: Ruins, retrofit, and risk. *Science Technology and Human Values*, 41(3), 547–565. <https://doi.org/10.1177/0162243915620017>
- INCODER. (2011). Analisis, diseño, construcción, de distritos de riego a nivel nacional (Fondo Nacional de Adecuación de Tierras). Código BPIN 0049000049999. Bogota, Colombia.

- Ingalls, M. L. (2017). Not just another variable: Untangling the spatialities of power in social–ecological systems. *Ecology and Society* 22(3), 20. <https://doi.org/10.5751/ES-09543-220320>
- King, B., Shinn, J. E., Yurco, K., Young, K. R., & Crews, K. A. (2019). Political Ecologies of Dynamic Wetlands: Hydrosocial Waterscapes in the Okavango Delta. *The Professional Geographer* 71, 29–38. <https://doi.org/10.1080/00330124.2018.1455524>
- Kneas, D. (2018). Emergence and aftermath: The (un)becoming of resources and identities in northwestern Ecuador. *American Anthropologist*, 120(4), 752–764. <https://doi.org/10.1111/aman.13150>
- Larkin, B. (2013). The politics and poetics of infrastructure. *Annual review of anthropology*, 42(1), 327–343. <https://doi.org/10.1146/annurev-anthro-092412-155522>
- Lawhon, M., Nilsson, D., Silver, J., Ernstson, H., & Lwasa, S. (2018). Thinking through heterogeneous infrastructure configurations. *Critical Commentary Urban Studies*, 55(4), 720–732. <https://doi.org/10.1177/0042098017720149>
- Loftus, A. (2020). Political ecology II: Whither the state? *Progress in Human Geography*, 44(1), 139–149. <https://doi.org/10.1177/0309132518803421>
- Luxion, M. (2017). Nation-building, industrialisation, and spectacle: Political functions of Gujarat's narmada pipeline project. *Water Alternatives*, 10(2), 208–232. <https://doi.org/10.31235/osf.io/ewa8b>
- Meehan, K. M. (2014). Tool-power: Water infrastructure as wellsprings of state power. *Geoforum*, 57, 215–224. <https://doi.org/10.1016/j.geoforum.2013.08.005>
- Mena-Vásconez, P., Boelens, R., & Vos, J. (2016). Food or flowers? Contested transformations of community food security and water use priorities under new legal and market regimes in Ecuador's highlands. *Journal of Rural Studies*, 44, 227–238. <https://doi.org/10.1016/j.jrurstud.2016.02.011>
- Mills-Novoa, M., & Taboada Hermoza, R. (2017.) Coexistence and conflict: IWRM and large-scale water infrastructure development in Piura, Peru. *Water Alternatives*, 10(2), 370–394. <https://www.water-alternatives.org/index.php/alldoc/articles/vol10/v10issue2/360-a10-2-10/file>

- Mitchell, T. (2002). *Rule of Experts: Egypt, Techno-Politics, Modernity* (First). University of California Press.
- Moreno, L. M., & Montenegro, M. (2021). Desterradas del río. Hidroituango y la destrucción del cuerpo-territorio por megaproyectos. Entre el interés general y el sostenimiento de la vida. *Iberoamericana – Nordic Journal of Latin American and Caribbean Studies*, 50(1), 84–93. <https://doi.org/10.16993/IBEROAMERICANA.520>
- Ostrom, E. (1993). Design principles in long-enduring irrigation institutions. *Water Resources Research*, 29(7), 1907–1912. <https://doi.org/10.1029/92WR02991>
- Painter, J. (2006). Prosaic geographies of stateness. *Political Geography*, 25(7), 752–774. <https://doi.org/10.1016/j.polgeo.2006.07.004>
- Perreault, T. (2008). Custom and contradiction: Rural water governance and the politics of usos y costumbres in Bolivia's irrigators' movement. *Annals of the Association of American Geographers*, 98(4), 834–854. <https://doi.org/10.1080/00045600802013502>
- Prieto, M. (2021). Indigenous resurgence, identity politics, and the anticommodification of nature: The Chilean water market and the Atacameño people. *Annals of the American Association of Geographers*, 112, 487–504. <https://doi.org/10.1080/24694452.2021.1937036>
- Reed, M. G. (2007). Uneven environmental management: A Canadian comparative political ecology. *Environment and Planning A: Economy and Space* 39(2), 320–38. <https://doi.org/10.1068/A38217>.
- Reinales, N. J., & Acevedo-Osorio, A. (Eds.). (2020). *Agroecología: Experiencias Comunitarias Para La Agricultura Familiar En Colombia*. Bogotá, Colombia: Editorial Universidad del Rosario. <https://doi.org/https://doi.org/10.12804/tp9789587842326>.
- Rocha López, R., Hoogendam, P., Vos, J., & Boelens, R. (2019). Transforming hydrosocial territories and changing languages of water rights legitimation: Irrigation development in Bolivia's Pucara watershed. *Geoforum*, 102, 202–213. <https://doi.org/10.1016/j.geoforum.2019.04.012>
- Schwenkel, C. (2015). Spectacular infrastructure and its breakdown in socialist Vietnam. *American Ethnologist*, 42(3), 520–534. <https://doi.org/10.1111/amet.12145>

- Scott, J. C. (1998). *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*. *Journal of Social History* (Vol. 33). Yale University Press. <https://doi.org/10.1353/jsh.2000.0050>
- Secor, A. (2004). "There is an Istanbul that belongs to me": Citizenship, space, and identity in the city. *Annals of the Association of American Geographers*, 94(2), 352–368. <https://doi.org/10.1111/j.1467-8306.2004.09402012.x>
- Smith, N. (2010). *Uneven development: Nature, capital, and the production of space*. University of Georgia Press.
- Sneddon, C. (2015). *Concrete revolution: Large dams, cold war geopolitics, and the US Bureau of Reclamation*. University of Chicago Press. <https://doi.org/10.7208/chicago/9780226284453.001.0001>
- Sneddon, C., Harris, L. M., Dimitrov, R., & Zesmi, U. O. (2002). Contested waters: Conflict, scale, and sustainability in aquatic socioecological systems rethinking water and conflict: An interdisciplinary approach. *Society and Natural Resources*, 15, 663–675. <https://doi.org/10.1080>
- Star, S. L., & Ruhleder, K. (1996). Steps toward an ecology of infrastructure: Design and access for large information spaces. *Information Systems Research*. <https://doi.org/10.1287/isre.7.1.111>
- Stoler, A. L. (Ed.). (2013). *Imperial debris: On ruins and ruination*. Duke University.
- Schwenkel, C. (2015). Spectacular infrastructure and its breakdown in socialist Vietnam. *American Ethnologist* 42(3): 520–34. <https://doi.org/10.1111/amet.12145>.
- "Techo de cosecha de arroz en 2020 no debe pasar de 520,000 hectáreas" (2019, December 4). *El Tiempo*. Retrieved from <https://www.eltiempo.com/economia/sectores/arroceros-dicen-que-han-esperado-los-distritos-de-riego-hace-4-decadas-440198>.
- Thomas, K. A. (2020). The problem with solutions: Development failures in Bangladesh and the interests they obscure. *Annals of the American Association of Geographers*, 110, 1631–1651. <https://doi.org/10.1080/24694452.2019.1707641>

- Thomas, K. A. (2021). Enduring infrastructure. In S. O'Lear (Ed.), *A research agenda for geographies of slow violence: making social and environmental injustice visible* (pp. 107–122). Elgar Research Agendas.
- Uribe, S. (2017). *Frontier road: Power, history, and the everyday state in the Colombian Amazon*. John Wiley & Sons, Ltd.
- Uribe, S. (2021). Suspensión: espacio, tiempo y política en la historia interminable de un proyecto de infraestructura en el piedemonte Andino-Amazónico colombiano. *Antipoda* 42, 205–229. <https://revistas.uniandes.edu.co/doi/pdf/10.7440/antipoda42.2021.09>
- Vera Delgado, J. (2015). The socio-cultural, institutional and gender aspects of the water transfer-agribusiness model for food and water security. Lessons learned from Peru. *Food Security*, 7(6), 1187–1197. <https://doi.org/10.1007/s12571-015-0510-5>
- Wakefield, S. (2018). Infrastructures of liberal life: From modernity and progress to resilience and ruins. *Geography Compass*, 12(7). <https://doi.org/10.1111/gec3.12377>
- Watkins, G., Mueller, S., Meller, H., Ramirez, M. C., Serebrisky, T., & Georgoulas, A. (2017). *Lessons from four decades of infrastructure project related conflicts in Latin America and the Caribbean*. [Report]. Inter-American Development Bank. <https://publications.iadb.org/>
- Zimmerer, K. S. (1994). Transforming Colquepata wetlands: Landscapes of knowledge and practice in Andean agriculture. In W. Mitchell & D. Guillet (Eds.), *Irrigation at high altitudes: the social organization of water control systems in the Andes* (pp. 115–140). American Anthropological Association.
- Zimmerer, K. S. (2000). Rescaling irrigation in Latin America: The cultural images and political ecology of water resources. *Ecumene*, 7(2), 150–175. <https://doi.org/10.1191/096746000701556680>
- Zimmerer, K. S. (2011a). Spatial-geographic models of water scarcity and supply in irrigation engineering and management: Bolivia, 1952–2009. In M. J. Goldman, P. Nadasdy, & M. D. Turner (Eds.), *Knowing nature: Conversation at the intersection of political ecology and science studies* (pp. 167–185). University of Chicago Press.
- Zimmerer, K. S. (2011b). The landscape technology of spate irrigation amid development changes: Assembling the links to resources, livelihoods, and agrobiodiversity-food in the

Bolivian Andes. *Global Environmental Change*, 21(3), 917–934. <https://doi.org/10.1016/j.gloenvcha.2011.04.002>

Zimmerer, K. S. (2017). Geography and the study of human-environment relations. In D. Richardson, N. Castree, M. F. Goodchild, A. Kobayashi, W. Liu, & R. A. Marston (Eds.), *International encyclopedia of geography: People, the earth, environment and technology* (pp. 1–23). John Wiley & Sons, Ltd. <https://doi.org/10.1002/9781118786352.wbieg1028>

Zimmerer, K. S., Rojas Vaca, H. L., & Hosse Sahonero, M. T. (2022). Entanglements of agrobiodiversity-food amid cascading migration, coca conflicts, and water development (Bolivia, 1990–2013). *Geoforum*, 128, 223–235. <https://doi.org/10.1016/j.geoforum.2021.01.028>