

Can grassroots movements in water conflicts drive socio-technical transitions in water management systems?

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ABSTRACT

Water conflicts open windows of opportunity for grassroots movements to transform water systems. However, academic fields studying social movements in socio-environmental conflicts are not well equipped to deal with complexity, non-linear dynamics, and emergent properties. Therefore, these fields rarely engage with long-term complex social processes and dynamics leading to systemic socio-technical changes. Researching water conflicts driven by grassroots movements, we ask whether and how the latter can influence a socio-technical transition of a water management regime. Through an emblematic water conflict in Mexico, we analyse the grassroots movement's trajectory since the conflict's inception by following the dynamic process of developing agency. Our findings show that throughout the conflict, the grassroots movement accumulated and mobilized diverse capitals to initiate water management strategies and practices that catalysed change in the water management regime by stalling the implementation of large infrastructures. Eventually, this led to the inception of a sustainable and just transition.

1. Introduction

"The new always happens against the overwhelming odds of statistical laws and their probability, which for all practical, everyday purposes amounts to certainty; the new therefore always appears in the guise of a miracle." —Hanna Arendt, Human condition

Systemic change has remained elusive in the water sector, especially where it is urgently needed in the face of several multi-faceted water-related crises imminent in many cities around the world as water demand keeps growing beyond sustainable limits (Srinivasan et al., 2012; Famiglietti, 2014; McDonald et al., 2014; Mekonnen and Hoekstra, 2016; Veldkamp et al., 2017; Flörke et al., 2018; D'Odorico et al., 2018). Meanwhile, societies have tried to mitigate water crises by addressing challenges of water quality, water quantity and ecosystem conservation through often controversial responses to prevent social disruptions and conflicts (Vörösmarty et al., 2010; 2013; Muller et al., 2015; Farinosi et al., 2018; Abel et al., 2019; Andrijevic et al., 2020; Bernauer, and Böhmelt, 2020).

Many of these responses are also contentious due to the ambiguous identification of the causes of water crises, and their implementation (often imposed) may generate further water conflicts due to the uneven distribution of costs and benefits (Martínez-Alier

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et al., 2016). Although these water crises and conflicts appear to result from ill-conceived responses and strategies, we argue that they are more likely the symptoms of unsustainable and inequitable water systems. Systemic change has long been associated with conflict (i.e. Hegel, 1998; Dewey, 1922; Coser, 1956; Callon, 1981; Long, 2003; Torrens et al., 2019). Therefore, water conflicts can also represent opportunities for marginalized actors to exert systemic change in water systems and redirect responses to address the structural causes of water crises, not only their symptoms. In this context, although studying water conflicts seems more relevant than ever, the field remains under-researched (Di Baldassarre et al., 2019).

In the political ecology literature on water conflicts, grassroots movements have a key role in foregrounding different worldviews and values that collide to control water in contexts of asymmetrical power relations, injustice, and water-based activism (Zwarteveen and Boelens, 2014; Rodríguez-Labajos and Martínez-Alier, 2015; Boelens et al., 2016). However, there is still a knowledge gap in understanding how grassroots innovations become institutionalized (Köhler et al., 2019), why societal transitions driven by social movements occur (Törnberg, 2018), how collective resistance can evolve social movements to exert socio-technical reconfigurations (Brink et al., 2023), understanding the agency of different actor groups (Markard et al., 2012), understanding how strategies of actors can exert transformative change (De Haan and Rotmans, 2018), and how grassroots movements in water conflicts can open decision spaces to incorporate alternatives that can reconfigure socio-technical systems (Godínez Madrigal et al., 2022). De Haan & Rotmans (2018) argue that many of these knowledge gaps are due to a poor explicit representation and conceptualization of actors and that most frameworks do not explore agency to explain transformative change.

This paper addresses the knowledge gap between water conflicts, grassroots movements and socio-technical transitions by focusing on the dynamic agency of grassroots movements analysed through longitudinal actor- and practice-oriented research. We ask whether water conflicts driven by grassroots movements can exert a water management transition, and if so, how? To answer this question, we analyse the Zapotillo conflict in Mexico. This is an 18-year-old conflict triggered by the implementation of a large infrastructure project that aims at transferring water to two of the most important cities in western Mexico and is considered a major intractable water conflict in Mexico (Ochoa-García and Rist, 2015). The conflict evolved to a point where the main actors in dispute have enrolled diverse actors from academia, politics, and legal experts to support their claim from the local to the international scale (Godínez Madrigal et al., 2020), resulting not only in the delegitimization and reconfiguration of the infrastructure project but also of the overarching governance and management regimes.

Our approach can contribute to understanding the underresearched dynamic processes and mechanisms driven by grassroots movements in water conflicts to foster water management transitions. Our analysis unravels in four stages. Firstly, we discuss existing literature on grassroots movements in transition studies and the social capitals approach to analyse the dynamics leading to the development of agency of the grassroots movement in the conflict. Secondly, we describe how data was collected and analysed. Thirdly, we present the results of the social capitals analysis. And lastly, we discuss and present conclusions of our analysis on the confluence of political and socio-technical processes where grassroots actors adapt, learn, and consolidate different kinds of social capital and respond to challenging situations with conscientious strategies to catalyse change in the coupled human-water system.

2. Grassroots movements and water conflicts toward socio-technical transitions

Social movements and collective action drive social, cultural and political change (Milward and Takhar, 2019), often advocating for structural transformations (Sovacool, 2022). While traditional views characterized movement participants as irrational (Jenkins, 1983), Resource Mobilization Theory (RMT) challenged this by framing social movements as rational actors, focusing on recruitment, motivation, and participation (Buechler, 1993).

However, RMT's emphasis on power and rational control overlooked vital determinants like culture, emotions, and ideology in collective action (Buechler, 1993; Vos et al., 2020). Departing from RMT, Scott (1985) argued that not all movements can mobilize revolutionary change; some engage in everyday acts of resistance (Brink et al., 2023). Some political ecology studies on water conflicts have documented the evolution of these initial everyday acts of resistance of grassroots movements, usually poor social groups, to becoming key actors resisting environmental injustice (Martínez-Alier, 2003, 2020). Movements go beyond the NIMBY (Not In My Backyard) label, becoming sustainability forces by opposing unsustainable policies (Temper et al., 2018).

However, a gap exists between resisting socio-environmental injustice and transforming a system since overemphasizing politics may hinder systemic technical transformations (Wesselink et al., 2017). Established social movement theories struggle with complexity, necessitating a transitions approach (Törnberg, 2018; Geels et al., 2015). Focusing on criticising and fighting existing structures without developing pathways to change and building concrete alternatives limits the transformative potential of social movements.

Therefore, the question is how social movements can develop feasible and concrete pathways to change. This approach considers structures, cultures, and practices in analysing systemic and generational changes (Loorbach et al., 2017; Rotmans and Loorbach, 2006). Transition studies adopt a multi-level perspective to understand the relationship between innovations and systemic change in socio-technical systems (Geels, 2005). At the macro level, a collection of societal systems is called a landscape, while at the meso-level, a societal system can be divided into sub-systems called constellations (De Haan and Rotmans, 2011). The constellation that dominates how the system functions is called a regime, while emerging constellations challenging the domination of regimes are called niches at the micro-level.

The literature on transition management has conceptual tools for understanding the dynamics of transitions, but sustainability transitions require a nuanced understanding of actors and agency (De Haan and Rotmans, 2011; 2018; Rauschmayer et al., 2015). Moreover, most studies have focused on technological innovation in wealthy countries (Haan and Rotmans, 2011), and fewer still on transitions driven by grassroots movements in developing countries (Seyfang and Smith, 2007; Hansen et al., 2018; Van Welie et al.,

2018; Frantzeskaki et al., 2018; De Hans and Rotmans, 2018; Kohler et al., 2019). These transitions face additional challenges due to informal, undemocratic, and non-egalitarian regimes (Hansen et al., 2018). Therefore, just transitions that aim to bridge the gap between local action and global change are demanded by social actors (Swilling and Anneke, 2012). This often leads to conflict, inherent in implementing transitions (Meadowcroft, 2011). More research is needed to analyze the role of conflicts and grassroots movements in undemocratic or oppressive contexts (Törnberg, 2018; Kircherr, 2018, 2019; Yuana et al., 2020).

To answer the question of how social movements can elicit a transition to a system reconfiguration even in oppressive contexts, Törnberg (2018) argues that for this to happen, social movements need free social spaces, understood as local niches “partly protected from the gaze of the powerful” to develop such alternatives. Avelino & Rotmans (2009) and Avelino (2017) theorize that a more nuanced understanding of power is necessary to explain this apparent contradiction. Power can be unpacked to differentiate power ‘over’ (social relation) and power ‘to’ (the capacity to act).¹ This distinction of power (‘over’ and ‘to’) and the mobilization of diverse resources explain niche development even in oppressive contexts (Avelino and Rotmans, 2009).

With this reemergence of the focus on power and empowerment, the resource mobilization theory can explain social movements and grassroots movements for sustainability transitions (Hisschemöller and Sizoiu, 2013; Raj et al., 2022). However, these resources or powers must be traced through the actors’ perspectives and practices. To research and understand social change, Long (2009) stressed the importance of looking at the actors’ day-to-day decisions, routines and strategies to advance their interests and cope with uncertainties, conflicts and cultural differences with other actors. Long’s theoretical innovation is to analyse actors through social interfaces, understood as “a critical point of intersection between different lifeworlds, social fields or levels of social organization, where social discontinuities based upon discrepancies in values, interests, knowledge and power, are most likely to be located.” (Long, 2003; pp. 243). At this social interface, actors change, coalesce with other actors and develop strategies to advance their interests more effectively at each iteration.

A related concept, “Critical moments”, is used by Yuana et al. (2020) to analyse conflicts in transitions and are defined as “particular events that allow negotiation of meanings, formulation or reformulation of dominant discourses.” Long (2003: 84) links the concept of critical moments or events to social interfaces when the latter articulates with “wider institutional frameworks and domains of activity.” Therefore, social interfaces can lead to critical moments or ruptures that give way to new conflict periods characterized by marked reconfigurations of the social field and actors’ accumulation of capitals. Under this approach, events in the conflict are understood as the results of underlying dynamic processes that connect the multiplicity and interaction of actors, strategies, institutions, frames, rules, cultures, and interests in distinctive periods. Moreover, Haan & Rotmans (2018) and Kingdon (1995) argue how actors’ strategies and powers are embedded in multiple streams, or wider societal value-driven dynamics (problems, policies, and political streams) that, when they intersect, can open up policy windows for actors to connect, or wider networks of actors to implement transformative change.

Therefore, water crises and conflicts allow grassroots movements to redirect efforts toward situated, bottom-up and context-specific alternative policies, projects and research agendas (Hess, 2015; Ramirez et al., 2020). Furthermore, to exert just transitions, grassroots movements have developed several capacities or skills to increase their political influence (Fligstein and McAdam, 2011; Smith et al., 2014; Torrens et al., 2019) and develop competing alternative framings of what the problem is and how to solve it to create an audience and mobilize it (Yuana et al., 2020). Grassroots movements collaborating with scientists influence research agendas and policy changes (Frickel et al., 2010; Villamayor-Tomas and García López, 2018; Fischer and Newig, 2016; Kivimaa et al., 2019; Hess, 2016). However, more research is needed from practice- and actor-oriented approaches to better outline specific grassroots practices and features that can destabilize a regime (Van Welie et al., 2018).

Ribot and Peluso (2003) outlined at least five strategies actors often use: social (legitimacy), knowledge (technical and infrastructure), relational (network), economic (funds), and based on authority, customs or the law (legal). These strategies provide the accumulation or depletion of what can be considered social capitals, understood as (im)material assets put to (re)productive use (Bourdieu, 1977), in the sense that actors can mobilize them to leverage their influence and interests in a social field. A social field is understood as spaces composed of material and immaterial elements (infrastructure, resources, information, technologies, rules, discourses and network configurations) wherein actors struggle and negotiate in different social arenas (Long, 2003). The concept of social fields can be differentiated from constellations in transitions literature by mobilizing the multi-level perspective of niches as constellations challenging the dominance of regimes, the most powerful constellations in a societal system (De Haan and Rotmans, 2011). In that sense, the actor dynamics to reconfigure a social field (by altering the power asymmetries of dominant and challenging constellations) can provide insights into patterns of transition (comparable to social change for Long) with larger implications in the structure, cultures and practices of a societal system (see Fig. 1 for a visualization of these concepts). In the present case study, the social field in dispute is the infrastructural and institutional regime of urban water supply in Western Mexico. This field is contested in many interlinked social arenas and operates in multiple arenas at different scales, such as public opinion, legal courts, decision-making processes and knowledge controversies.

3. Methodology

We pursued the following steps to analyse the agency or the ‘power to’ as conceptualized by Avelino & Rotmans (2009) of grassroots movements to foster water management transitions in contexts of water conflicts. First, we characterized the structure,

¹ This differentiation is by no means new. In the 17th century, the philosopher Baruch Spinoza (1989) disentangled the concept of power by recurring to the Latin differentiation of power between *Potere* and *Potentia*. See Godínez Madrigal (2022) for further elaboration on this discussion.



Fig. 1. Sustainability transitions conceptual framework from an actor- and practice-oriented perspective.

culture and practices of the water management socio-technical system in Mexico to understand the context of the conflict and why the grassroots movement aimed to foster a systemic change, as suggested by Haan & Rotmans (2011). To do so, we consulted the literature on the water management regime of Mexico and the specific water crisis that led to the Zapotillo conflict.

Second, since our primary goal in this paper is to show whether and how grassroots movements can foster water management transitions, we tracked and analysed the origins and evolution of the grassroots movement's agency by developing certain capacities that we conceptualized as capitals through social interfaces in arenas. We hypothesise that the development of actors' capitals as the object of analysis can provide insights into the patterns and storyline of socio-technical transitions. To test this, we mobilized the theoretical and methodological work of Long's actor-oriented research (2003) and the practice-oriented research of Ribot & Peluso (2003) and Bourdieu (1977). We have chosen this methodology due to our positionality as researchers and our curiosity about whether a sustainability transition could be exerted from the bottom up by usually dominated actors in social movements. We were not regarded as insiders by the grassroots movement but as socially engaged researchers. This positionality also allowed us to interact in events and workshops we organised even with the actors supporting the Zapotillo project.

We analysed agency as expressed in actors pursuing their interests through strategies and capital accumulation in a social field. We described the practices of key actors driving an evolving socio-technical transition by tracking their strategies and the dynamics of their capitals over an 18-year period of the Zapotillo conflict. Since 2005, two of the authors made actor-oriented longitudinal participatory observations in intensive fieldwork periods during the ordinary daily life of members of the grassroots movement in the summer of 2010, fall of 2017, winter of 2018 and summer of 2021, and extraordinary events like demonstrations and meetings with different key actors with the social movement, specifically the dam-affected communities of Temacapulín, Acasico and Palmarejo. These two authors kept diaries describing practices, perspectives, discourses and interactions in their own environments and between different actors, especially government representatives and allied international and civil society actors. They also consulted newspapers describing important events to which the authors could not be present or did not have access and then explored the events during semi-structured interviews. Through these activities, they reconstructed a thick actor-oriented description of the conflict storyline's main events and underlying dynamic processes.

Complementing participant observation, the first author conducted 31 in-depth semi-structured interviews with key actors, both in favor and against the Zapotillo project, to limit any possible bias in our analysis between 2017 and 2021 (Table 1). The duration of interviews averaged 1 h and 36 min. The questions asked referred to elaboration and reflection of actors' successful strategies, the challenges and stresses they routinely faced when deploying strategies in the social field, the setbacks and failures they endured, the interaction with allies and foes, and critical moments that changed the course of the conflict. Due to the sensitivity of the information provided, some interviewees were anonymized. They were informed and consented to use the interview information for the research. The first author manually transcribed the interviews and analysed the data by coding in a spreadsheet how intentions, motivations and strategies were linked to the perception of advances of the struggle. This allowed us to define various social arenas where different kinds of strategies were deployed and conflict periods were defined based on their dynamic strategies, interests, motivations and framing of the water crises in the cities and the conflict.

We understand that when actors pursue a social strategy, they acquire social capital to be regarded as legitimate actors in a specific social field that is crucial for such actors, i.e. finding solutions for water shortages in large cities. This capital can be found in the public opinion arena. With a technical strategy, they acquire useful technical capital to inform and weigh decisions, negotiate and counter common practices and cultures of technical and scientific actors about the social field in the knowledge arena (i.e., knowledge about infrastructure and the human-water system). With a legal strategy, actors acquire legal capital that can obstruct other actors' strategies and generate jurisprudence to influence the legal structure of the specific social field in the legal arena materialized in courts and judges' rulings. A political strategy renders a type of capital that influences decision-making in the political arena of the executive and legislative branches of power. A network strategy garners relational capital that facilitates the connection and allegiance with actors that share other high social, technical, political or economic capitals. This kind of capital can be accumulated in arenas of social connections. Finally, an economic strategy aims to find financial resources to support the actors' livelihood during the conflict and fund other strategies in different arenas (e.g., paying for scientific studies).

Moreover, between 2017 and 2019, the authors organized two stakeholder workshops in Temacapulín and Guadalajara with the objective to analyse under their perspective the conflict vis-à-vis the coupled human-water system, reflecting which kind of strategies the grassroots movement followed to achieve their objectives and analyse the potential and efficacy of implementing different technical solutions other than the Zapotillo project through participatory modelling. Seventeen members of the grassroots movement attended the first workshop, and the second workshop was attended by fourteen people from different organizations, including Jalisco's government, the College of Engineers, Conagua, NGOs, academics and the grassroots movement. The first author wrote and

Table 1
List of interviewees and workshop participants.

Groups of actors	Number of interviewees	Workshop 1	Workshop 2
Grassroots movement	11	17	4
NGOs supporting the grassroots movement	4	1	2
Network of academics supporting the grassroots movement	6	2	2
Jalisco government	4		1
Conagua	1		3
College of Engineers (in support of the Zapotillo project)	4		2
University of Guanajuato	1		

Table 2

Accumulation of capitals of key actors during the first conflict period “The threat” (2005–2010).

Actors / Capital accumulation	Social	Legal	Political	Relational	Economic	Technical	Main strategic arena
Grassroots movement	Low – Dominated actor due to lack of capitals.	Medium-low – Legitimate human rights focus, but without legal clout to enforce any recommendation.	Absent	Medium – Accompanied and supported by three NGOs.	Low – Dependent on their own resources and the NGOs’ resources.	Absent	Public demonstrations against the Zapotillo project in the public opinion arena and a legal strategy based on a human rights approach in the legal arena.
Coalition in favor of the Zapotillo project	High – Dominant actor of the water management system.	Medium – The legal challenges hurdled by the grassroots movement were easily dismissed.	High -Infrastructure decision making without consultation with the communities.	Medium – Support of the engineering community of Jalisco.	Medium – Budget disputed every year with other governmental priorities.	High - Engineering capacity of the National Water Commission and IMTA.	Relying on their social, political and technical capital to develop the project based on a fait accompli strategy in the political arena.

Table 3

Accumulation of capitals of key actors during the second conflict period “Grassroots cross-learning” (2010–2013).

Actors / Capitals accumulation	Social	Legal	Political	Relational	Economic	Technical	Main strategic arena
Grassroots movement	Increased – Their struggle is known and increasingly being supported by civil society to the point of taking over the dam’s construction site.	Increased – In addition to a human rights approach, they followed an unconstitutional action against the illegal fait accompli strategy.	Increased – Sympathetic political opposition in the Congress of Jalisco built together the unconstitutional claim with the Supreme Court.	Increased – The organization of a meeting and attendance of multiple national and international social movements generated varied support and media attention.	Increased -Movement supported by wealthy migrant organizations from the USA.	Increased – Grassroots movement learning of the negative effects of dam and the political economy of infrastructure changed their position vis-à-vis the Zapotillo project.	Change in the frame – from NIMBY to the need for a substantial change in the water management system in the connections and relations arena as well as the legal strategy that led to halting the dam in the legal arena.
Coalition in favor of the Zapotillo project	Decreased – Their discourse strategy does not generate social sympathy, and illegal missteps question their rule over the water management system.	Decreased – Supreme Court rules against continuing the Zapotillo dam at 105 m high.	Decreased -The illegal decision to increase the dam’s height curtailed their decision-making power.	Stagnated	Stagnated	Stagnated	Legal and discursive strategy based on a utilitarianism perspective: benefiting the greatest number of people despite the sacrifice of a few.

Table 4

Accumulation of capitals of key actors during the third conflict period “Political formation” (2013–2018).

Actors / Capital dynamics	Social	Legal	Political	Relational	Economic	Technical	Main strategic arena
Grassroots movement	Increased – Communication campaigns have an impact on social media, and journalists cover most of the movement's actions.	Stagnated – The Zapotillo dam is in legal limbo after the Supreme Court ruling. This ruling reconfigured the legal arena by following acting protocol for judges, instructing them how to rule considering human rights abuses in cases of large infrastructural projects.	Increased – Creation of the citizen water observatory officially supported by the government and overtly critical of the Zapotillo project.	Increased – International renowned actors with expertise in water management support the movement.	Stagnated	Increased – Technical arguments of international experts cast serious doubts and weigh in knowledge controversies about the project's feasibility.	Frame reinforcing in the political arena: The Zapotillo project is socially and environmentally unfeasible and riddled with corruption.
Coalition in favor of the Zapotillo project	Decreased – Their rule over the water management system and technical capacity is increasingly questioned in social media and traditional media.	Increased – Jalisco and Guanajuato state governments found a way to circumvent the 2013's Supreme Court ruling.	Decreased – The government has a new actor lobbying against the Zapotillo project with the Observatory.	Decreased – The UNOPS fiasco left the government without any external supporting actors.	Stagnated	Decreased -UNOPS was hired to settle knowledge controversies, but its technical report resulted in a public fiasco, discrediting both the technical capacities of the national water agency and UNOPS.	Looking for external technical support in the knowledge arena for the Zapotillo Project and circumventing the 2013 Supreme Court ruling in the legal arena.

Table 5

Accumulation of capitals of key actors during the fourth conflict period “Projects of life” (2018–2021).

Actors / Capital accumulation	Social	Legal	Political	Relational	Economic	Technical	Main strategic arena
Grassroots movement	Increased – Social and political affinity with the new federal government opened the door to expand the decision space to resolve the conflict.	Stagnated	Increased – Grassroots movement reached an agreement with the President and water agency.	Increased – Previous relationships with government insiders facilitated a direct relationship with the Mexican president.	Stagnated	Increased – Technical alternatives developed by an international network of renowned specialists and discussed with official governmental support.	Seeking alliance with government insiders and another change of frame: real systemic change in the water management system is only possible through technical concrete solutions in the knowledge arena.
Coalition in favor of the Zapotillo project	Stagnated – Although led by a popular President, the communities pushed back an initial offer by Conagua, and accepted the grassroots movement’s counteroffer of retrofitting the infrastructure, even against the interests of Jalisco and Guanajuato governments.	Stagnated – Despite finding a way to circumvent the Supreme Court’s ruling, the federal government’s position overpowered the states’ legal capital.	Increased – The president ordered Conagua to accept the grassroots movement’s demands.	Stagnated	Increased – The President had the capacity to find financial resources to fund the Zapotillo dam retrofitting works.	Increased – Under the command of the President, the grassroots movement trusted Conagua’s capacity to retrofit the Zapotillo dam.	Giving in to the demands of the grassroots movement as the only way to resolve the conflict and still (partially) allocate water resources to Guadalajara.

kept a research diary and took photographs describing the insights and reflections elicited from the interaction of actors during the workshops. Later, in 2021, the authors conducted participant observation in the negotiation process between the communities and the water authorities over the future of the Zapotillo project and the communities, of which the first author also wrote the impressions, interactions between actors, and discourses in the research diary.

The analysis of the evolution of the actors' capitals was considered key in understanding whether and how the grassroots movement could drive a socio-technical transition of the infrastructural and institutional configuration of urban water supply in Western Mexico. Since capitals are relative to the social field at hand and depend on the perspectives of other actors, it is difficult to analyse their evolution and measure their accumulation (Velasco-Yañez, 2000, 2005; Robson and Sanders, 2009). However, through a thick description of social interfaces in conjunction with reflective semi-structured interviews, we could characterize social discontinuities where there have been changes in actors' capitals, strategies and mental frames, but also objective changes such as decisions, agreements, decrees and allegiances. From a transition perspective, the accumulation of capitals occurs not at the scale of niches but only through the interface of actors in the different arenas of constellations that directly affect the water management regime. At the end of each conflict period, we assessed the evolution and reconfigurations in the accumulation of the actors' capitals (increasing/decreasing/stagnation) as an outcome of the different arenas in which the conflict actors struggled. We used this to identify the complex social processes and dynamics underlying the different periods of the conflict.

4. Results: Zapotillo water conflict and social mobilisation for water management transitions in Mexico

4.1. Historical background

Guadalajara and León are two large cities in Western Mexico facing severe water shortages for millions of inhabitants. In response to new water allocation requests, Conagua, Mexico's national water commission, allocated substantial water volumes from the Verde River basin in 1995. However, a water transfer project, the Zapotillo project, only started in 2005. This project is part of a long continuation of a supply-augmentation strategy based on large-scale infrastructure development to solve water management problems in Mexico (McCulligh and Tetreault, 2017; Godínez Madrigal et al., 2022).

The period between the 1940s and 1970s saw the heyday of infrastructure development, characterised by water resource development (Wester et al., 2009). The decision-making process was characterized as centralized, undemocratic, and driven by vested interests (Wester, 2008). Due to a lack of financial resources in the 1980s, the infrastructural development slowed down (McCulligh and Tetreault, 2017). The increase in demand and limited water resources led to multiple urban water conflicts across the country (Castro, 2007), which prompted the World Bank to sponsor a water management reform in the 1990s (Wilder, 2010). This reform was based on principles of decentralization, increased public participation, and the recognition of water as an economic resource. The market was presented as an effective alternative to help finance urgent large-scale infrastructure and, at the same time, operate and manage water utilities more effectively. The privatization of many water utilities followed as the state was perceived to deliver inefficient services due to politicization (Herrera, 2017).

However, many promises have yet to materialize. The water management regime in Mexico still relied heavily on increasing large-scale infrastructure development to solve impending water crises. And despite private participation in infrastructure development, old practices remained unchanged. Although formally encouraged, user participation was deterred by the absence of precise, actionable mechanisms to incorporate the users' contributions in decision-making (Caire Martínez, 2004; Hoogesteger and Wester, 2017). Thus, water authorities exerted their power with a lack of transparency and a weak legal framework, and the *de facto* decision-making still depended almost entirely on them. This technocratic approach could not remove vested economic and political interests, and public participation was considered a simulation (Muñiz-San Martín and Torres-González, 2012; Godínez Madrigal et al., 2019). With some exemplary exceptions, most water utilities that adopted management principles and policies characterised as neoliberal in Mexico are still lagging in terms of cost recovery, reduced non-revenue water, and access to safe drinking water for the general population (COMDA et al., 2019; Herrera, 2017). Informal and fragmented water supply and sanitation regimes are prevalent (Godínez Madrigal et al., 2018; 2022), and fierce competition for water has worsened due to urban growth, overallocation of water rights and neglect in infrastructure maintenance (Reis, 2014; 2017; Ochoa-García, 2015). Over-exploited aquifers reflect the authorities' incapacity to monitor and inspect groundwater users (Hoogesteger and Wester, 2017), resulting in a decline in trust in official institutions (Reis, 2014).

In this context, hydraulic bureaucrats in Conagua, the national water agency, have mobilized a narrative pinning large infrastructural projects on water security as essential for the country (CEA-Guanajuato and Conagua, 2018). Therefore, political forces have lobbied for a new legal framework for decades to ease obstacles to implementing large infrastructural water projects such as inter-basin water transfers (López-Ramírez and Montoya, 2015). Meanwhile, nationwide social movements have counter-advocated a new water law that would increase the influence of civil society in water management (Wilder et al., 2020). The Zapotillo conflict is embedded in these broader social, political, legal and economic water management structures, cultures and practices in Mexico.

4.2. The Zapotillo conflict

In the analysis of the conflict, we identified four distinct periods of the conflict where the main actors changed their positions and influence in the conflict based on the accumulation of different kinds of capitals (Fig. 2). We have named these periods in the same way some interviewees of the grassroots movement named them. The first period conceptualized as "The threat", started with the construction of the Zapotillo dam in a context where the affected communities hardly possessed any capital nor awareness to understand

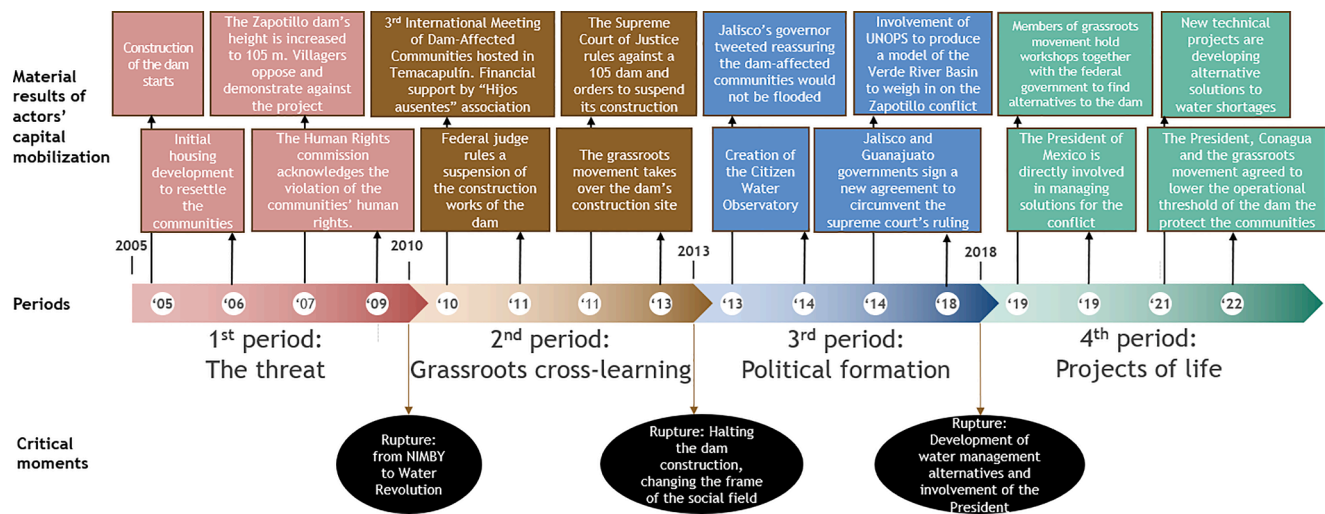


Fig. 2. Conflict periods of the Zapotillo conflict.

the Zapotillo project's impacts and resist the government's framing. The second period was characterized as a "Grassroots cross-learning" due to the intense interaction between many grassroots movements, during which the affected communities learned the political economy and vested interests behind large-scale infrastructure development. The third period, dubbed "Political formation", consisted of the grassroots movement consolidating their discourse that criticised the infrastructure project as an attempt to privatize water and framed their movement as one to protect their human rights and advance a "Water revolution". The most significant milestone of this period was halting the dam's construction. In the fourth and last period, "Projects of life", the grassroots movement considered the water transfer project "a project of death" for the river and sought to consolidate the technical soundness of a socio-technical transition in the water management system to support "Rivers for life". The government, now led by politicians sympathetic to social movements, acquiesced to the grassroots movement's demands for a reparation program that included reducing the operation of the Zapotillo dam and physically retrofitting the infrastructure.

4.2.1. The threat (2005–2010)

When the inhabitants of Temacapulín, Acasico and Palmarejo learned about the Zapotillo project in 2005, they turned to the local priest for guidance and advice, who assumed a leadership role that would continue throughout the conflict. At the time, the dam-affected communities did not immediately reject the project because Conagua, the national water authority, mobilized its technical and legal capitals to appease the villagers by promising that its "technical competence was so advanced that it is possible to develop large infrastructure in favour of the people without affecting them"² (Espinoza Íñiguez, 2010).

However, without adequate public consultation, Conagua increased the dam's initial design height from 80 m to 105 m in 2007, which would unavoidably flood the three villages. At that point, the communities publicly opposed the project since it was obvious that the Temacapulín, Acasico and Palmarejo villages would be flooded, and their inhabitants resettled.

The resistance had a clear motivation: the three communities wanted to be spared, and the dam relocated to somewhere else, as the priest explained: "When [the then head of Jalisco's water authority] came to Temacapulín, his position was that Temacapulín needs to get out [resettle]. And I remember my response was... I think it's even recorded... bring water to León from Tabasco or Chiapas [tropical regions in Mexico characterized by vast water resources but located more than 1000 km away], build an aqueduct. I mean... I used to have a bit of a backward mentality back then." (Interview 15/12/2018). This indicates an initial NIMBY attitude of the grassroots movement.

During this time, the government of Jalisco's main objective was to mobilize its economic capital to offer a new housing development dubbed Talicoyunque as compensation for expropriating the communities' homesteads. This strategy worked at the beginning, as some of the inhabitants accepted this early transaction. However, soon the government could not fulfil its promises of material compensation due to budget hassles. Therefore, many inhabitants, disappointed by the unfulfilled promises, joined the ranks of the growing activist group against the project. An engineering lobbyist in favour of the project who asked to be anonymized described that: "The government never fulfilled its promises to compensate [the communities], and everybody had accepted, practically everybody [members of the community accepting the compensation in exchange for selling their land and houses]. Then, when things heated up because the state did not keep its promises [of properly compensating all the dam-affected persons], many organizations entered [to the communities] to change their minds [and reject the government's compensation plan], especially ITESO [the Jesuit University in Jalisco]. [...] The State has not kept its promises. It is a very serious thing that I am saying, but that is the reality." (Interview 14/04/2017).

Over the years, members of the communities felt harassed by the government's tactics to convince them to sell their houses and their public portrayal as being responsible for stopping progress and being condemned to poverty (Espinoza Íñiguez, 2010). Because of that, the priest and other members of the communities organized public demonstrations at the dam's site and in the city of Guadalajara, a strategy that continued over the years. They also sought legal advice to advance a human rights strategy and strive for internal social cohesion.

COA Collective, a leftist *pro bono* organization, provided free legal advice to the members of the communities and farmers to stand a fight against the project; IMDEC, the oldest NGO of Jalisco (1963) and the Fundación Lerma-Chapala-Santiago (FLCHS) provided the organizational experience to support and consolidate the grassroots movement. Especially IMDEC, a regional NGO focused on community development, has supported the affected communities for the past two decades because they "understand that these social conflicts respond to a powerful system which requires support in the medium to long term" (Interview with grassroots activist, 25/11/2021).

COA Collective and representatives of the communities elaborated a legal strategy nested in a human rights framework and a discursive strategy aimed at mobilizing legitimacy (social capital) by highlighting Temacapulín's cultural heritage through public festivals. First, in 2009, they presented their case to the Interamerican Commission of Human Rights in Washington, D.C. Later, they took advantage of the constitutional reform of 2011, which elevated numerous international human rights treaties previously signed by Mexico to the highest rule of law. Referring to this reform, the lawyer of the communities said, "Not only verdicts were globalized, but also our rights [...] A [social] fight that is not accompanied by a claim of rights is easily disarticulated and delegitimized" (Interview 10/05/2017). This strategy yielded good results when the Human Rights State Commission released a recommendation urging the government to cancel the Zapotillo project due to human rights violations against the inhabitants of the three communities (CEDHJ, 2009).

² Conagua had initially assured the villagers that they would build dikes to protect the villages from flooding.

However, due to the institutional configuration of the Human Rights Commission, the government could disregard such recommendations without consequences, which they did by continuing to construct the dam. Activists against the project saw this as a “*fait accompli*” strategy. A completely built dam would overcome procedural illegalities and start operating.

4.2.2. Cross-learning experience with other grassroots movements (2010–2013)

In 2010, members of the communities sought to expand their relational capital by hosting the 3rd international meeting of dam-affected communities, attended by hundreds of representatives throughout the American continent. During the preparation of the meeting, they coined a catchphrase, “The eyes of the world are set in Temaca”, to portray the growing internationalization of the movement. Moreover, they found international support from Temacapulín’s migrant network of “*Los hijos ausentes*” in the United States, who contributed financially (economic capital) and with media exposure (social capital).

This experience allowed the dam-affected communities to learn from other grassroots movements that have struggled against the imposition of dams in their territories. The villagers learned about all the potential negative effects of a large-scale project in their communities and territory. They also discussed the political economy fostering these kind of projects, which they argued are embedded in a capitalist economy of “accumulation by dispossession” of the natural resources in the control of marginalized communities. This interaction with other experiences gave the grassroots movement a different perspective of their struggle, which changed their frame towards the conflict. They not only opposed the Zapotillo project but now envisioned a just and sustainable water management.

These network and social strategies yielded benefits which marked a growing sympathy among the public in Jalisco for the inhabitants of Temacapulín and their cause, as analysed by Pacheco-Vega & Hernández Alba (2014). The legal strategy also yielded benefits when, in 2011, a federal judge resolved to suspend the dam construction works (Verduzco-Espinoza, 2019). However, the head of Jalisco’s water authority did not abide by the suspension by exploiting legal loopholes.

These loopholes were caused by a weak legal framework concerning water transfer schemes, which are only briefly mentioned in the Water Law (Cabrera Hermosillo, 2018). Ultimately, this allowed the water authority to use discretionary decision-making and procedures. When asked about his impressions on the 2011 federal court ruling, the head of Jalisco’s water authority answered: “I firmly trust that The Zapotillo [dam] will continue because it is the water supply for more than 2 million people [...] Hereby, we are undoubtedly favouring a majority against a minority” (Pese a amparo, 2011, Feb 02). This comment would represent the utilitarian argument of Jalisco’s government’ for the dam’s completion.

This situation irritated members of Temacapulín’s movement and compelled them to undertake a more direct action: taking over the Zapotillo dam construction site in 2011. They infiltrated the site by pretending to be construction workers and paralyzed the construction process for some days. However, they could not sustain such action for long and left the premises, exhibiting a lack of economic capital and legitimacy (social capital) for exerting and sustaining actions outside the law.

However, the focus on a legal strategy also showed limitations because of the power disparity between the actors: “If we want to litigate well, we are tied to the place, we cannot leave, we have no right to go on holidays. Two or three lawyers need to be there so that someone can replace you if one wants to go on holiday. Our lives are very stressed [...] Lawyers that want to work on these issues are few [...] There is an asymmetry of power; in the trials, the communities are at a complete disadvantage; we do not have a staff of lawyers. We used to say that Abengoa [the construction company in charge of building the aqueduct to the city of León] has more lawyers than engineers” (Interview with COA Collective lawyer 08/10/2018).

Therefore, in 2012, to balance their struggle in the legal arena, they explored a socio-legal strategy by lodging a constitutional complaint against the 105 m dam to the Supreme Court with the help of local congresspeople. In 2013, the Supreme Court ruled that due to an unconstitutional procedure committed by Jalisco’s government, the Zapotillo dam could continue, but never beyond the 80 m high mark. The dam construction was stalled. This was regarded as the first unlikely success of the grassroots movement against a seemingly unsurmountable foe.

4.2.3. Political formation (2013–2018)

Given the regional and national exposure of the grassroots movement of the dam-affected communities, several politicians during electoral campaigns intended to bank on the grassroots movement’s rising popularity for their own interests. This meant the grassroots movement’s high legitimacy (social capital) could be used or manipulated for political purposes. For example, Jalisco’s governor tweeted, “I repeat it: Jalisco must be the main beneficiary of the decisions and not the one who is affected. We will not flood Temacapulín” (Sandoval, Aristoteles (AristotelesSD) Jan 13, 2013). An anonymous water management think-tank representative (Interview 14/05/2017) considered that “[The tweet] complicated everything. It forced him to keep his promise [not to flood Temacapulín], especially because in those times when he was still looking “*presidenciable*” [a term used for any politician planning to become a presidential candidate]. Now he knows he no longer is. So, he is looking to “pass the hot potato” [to the next governor] and another six years will pass by [until the next presidential elections].”

In parallel, some farmers in the Los Altos region started to worry that the Zapotillo project might affect them negatively. IMTA (the technical branch of Conagua) mobilized its technical capital by conducting a study that concluded that the basin had more than enough water to guarantee a water transfer (IMTA, 2015) and that Los Altos farmers would not be affected. Moreover, the government actively promoted this notion of abundance of water to increase their relational and social capital in the region, especially for large agricultural producers in Los Altos. An anonymous interviewee within Jalisco’s government confirmed that two top government officials visited the director of the largest egg producer of the region (and second largest producer in the world, WATTAgNet 2015) to convince him that he would not be affected by the water transfer scheme since it would be only surface water (most livestock and poultry farmers use groundwater for their production processes due to its better quality compared to surface water). Instead, they claimed, the region would benefit from the scheme since the aqueduct would supply water to many urban settlements on its way to León.

However, a group of farmers worried about groundwater over-exploitation and doubtful of the government's promises formed CONREDES, an NGO to promote sustainable development in the Los Altos region. This organization, accompanied by other farmer associations and the catholic church in the region, sought a socio-network strategy to galvanize farmers against the Zapotillo project and lobby the government to cancel the water transfer to León but supported the completion of an 80 m Zapotillo dam to use the water to promote the region's future agricultural development.

These grassroots movements expanded their network strategy by coalescing with academic networks fostered by ITESO, a local Jesuit university with ample legitimacy (social capital) and (international) relational capitals. This coalition promoted the internationalization of the conflict by involving a representative of the New Water Culture Foundation from Spain, who publicly denounced the Zapotillo project as unsustainable, unfair and short-sighted. The assessment also included the threat to the donor basin's development and the human rights of the inhabitants of Temacapulín. The respected voice of this actor increased the social capital of the movement, and the involvement of CONREDES and ITESO marked a third conflict period since it fostered the organization of farmers in the region to oppose the Zapotillo project.

In 2014, at the height of the movement's socio-relational capital, the deadlock to the project imposed by the Supreme Court ruling in 2013 and the political aspirations of the Governor of Jalisco led the latter to propose the creation of a Citizen Water Observatory. The Observatory was mandated to submit binding recommendations to the State of Jalisco and its local governments. It comprised multiple university representatives, civil agricultural and business associations, the church and international water associations.

In the meantime, many grassroots network activists had received numerous anonymous death threats should they continue their activism, which continued yielding more successes. The grassroots movements assumed the government was behind the intimidation acts and refused to partake in any governmental initiative. So, although IMDEC and the community representatives were invited to be part of the Observatory, they declined. This snub created a rift between the Observatory and the block of actors led by Temacapulín that further widened over time.

However, the government was not a monolithic actor. Jalisco's government had the perception of an absence of neutral technical and scientific actors within Mexico. So, in 2015, Jalisco hired UNOPS (United Nations Office for Project Services) to "depoliticize" the conflict, settle the knowledge controversies, and try to find an optimal solution based on more updated social and hydrological information (Godínez Madrigal et al., 2020). In this context, this meant following a strategy to increase the social and technical capitals of the Jalisco government to counter the perception of representing an obsolete water management approach. Hiring UNOPS to compile more than 60 years of hydrological data independently and develop a water resources model to explore scenarios with different solutions was a good idea initially. Even members of Temacapulín welcomed the team's involvement in 2015. However, the UNOPS study results, presented in mid-2017, supported the construction of the Zapotillo dam at 105 m height. The governor of Jalisco immediately announced that the project would continue and that the villagers would need to be resettled. However, serious inconsistencies were immediately identified in the UNOPS study and criticised by Temacapulín and the Observatory, who denounced that the analyses and results were biased and tailored to legitimize the project (Godínez Madrigal et al., 2020). The hyped UNOPS involvement resulted in a fiasco and the Jalisco government losing crucial social and technical capital in the arenas of public opinion and knowledge controversies.

To capitalize on this governmental blunder, both the grassroots movement and the Observatory pursued similar communication strategies to increase their social capital in the public opinion arena: "Our bet is to talk to society, the public opinion, so that it may be our greatest judge" (Interview with the priest, 10/07/2017), even if that meant describing the case in the media as a dull mantra. By 2017, the relationship with the media had gotten into a frenzy (more than one thousand newspaper articles on the conflict were written from 2005 to 2020). The grassroots movement and the Observatory appealed to environmental journalists who would give them special coverage. As a result, an anonymous interviewee within the Observatory described her routine as: "Every day is a new *periodicazo* [a newspaper article with high impact], so now who knows what happened?! Hurry, prepare a report! Call this or that person and ask for a meeting! Every day I was reading the newspapers, expecting to read the following *periodicazo*" (Interview 01/06/2017).

Although both collective actors followed the same strategy, they elaborated different messages to get across. The grassroots movement framed its position as the human rights of the communities that must be respected vis-à-vis a project with vast technical inconsistencies, disinformation, broken political promises (e.g., the famous tweet of the governor of Jalisco), and irregularities. Furthermore, Temacapulín highlighted their cause not as NIMBY any longer but as "*La Revolución del agua*" (the water revolution), which can be seen printed on almost every corner of the streets of Temacapulín. This change in narrative framed the Zapotillo project and Temacapulín's cause as a necessary evolution from water management characterized by corruption, privatization, and unsustainability to an inclusive and sustainable water management paradigm under the motto of "water for all, water forever". Their large social media following showed that this narrative resonated with the public.

By 2017, new electoral campaigns commenced for the office of Jalisco's governor, and again, the Zapotillo conflict became a political arena to gain social capital. However, after the elections, Temacapulín's cause was discarded. The new governor decided to continue with the Zapotillo project with the strategy of diminishing the social capital of the Observatory. After losing many of its founding members, the governor publicly requested the Observatory to be disassembled due to its lack of internal plurality of opinions, deficient democratic practices, and diminished relevance. Moreover, the governor implemented a legal strategy to circumvent the Supreme Court ruling that stopped the construction of the Zapotillo dam at 80 m high. Jalisco's government lobbied to sign a new agreement with Guanajuato, this time supported by the Congress of Jalisco, which had been the main constraint in 2007.

For the first time in years, with a weak Observatory and a circumvented 2013 Supreme Court ruling, the conflict seemed to tilt towards completing the Zapotillo project.

4.2.4. Projects of life (2018–2021)

During the third period, members of the grassroots movement realized the limitations of their social and network strategies since different political interests made alliances fragile (i.e., the Observatory). In a context where the government of Jalisco seemed to have succeeded in continuing the Zapotillo project, the leadership and spiritual roles of the priest in keeping the grassroots movement united and energized were critical. A majority of the grassroots movement tended to passivity. Still, the priest continued to spend time and resources to inspire the rest of the movement's members and keep the group united despite multiple attempts from the government to rift the movement apart by offering kickbacks to some members. To inspire and devise a new promising pathway, the movement's efforts diverted to adopt a technical strategy by focusing on the technical alternatives of the Zapotillo project (IMDEC, 2018; 2019). Even the priest, still leading the movement, enrolled in a university to study for a master's in rural development and wrote a thesis supporting the need for a dialogue between local knowledge in the three villages and scientific knowledge (Espinoza Iñiguez, 2022).

For many years, local academics from Guadalajara and León – linked to international experts and networks – had proposed alternatives to the dam. Still, such proposals were characterized as being either too abstract or unreliable. A group of academics collectively argued that the dam would not be needed if only water resources were managed in an integrated manner (Aceves Avila et al., 2018). Others insisted on alternative solutions, such as rainwater harvesting, but could not systematically estimate their potential or develop coherent plans to undertake them (i.e., Gleason Espíndola et al., 2018).

With the new focus on technical alternatives, in 2018, the authors of this paper organized a participatory modelling workshop with key actors involved in the regional water conflict to analyze and collectively discuss the potential of infrastructure and water management alternatives and, in doing so, increase the technical and social capital of the movement. A representative of IMDEC welcomed this strategy to increase their capital in the knowledge arena: “The adoption of these kinds of alternatives has not been considered [by decision makers]. And, sadly, the business people and official [governmental] discourse is that our resistance movement only opposes but does not propose anything. And that's the issue, not knowing how to propose solutions for aquifer recharge, water harvesting, modernizing agriculture and efficient water systems” (interview 07/12/2018).

At the same time, the arrival of a new left-wing president in 2018, who won the national election with a landslide, created a window of opportunity in the socio-technical landscape for actors opposing the project. The new Mexican President was known to be sensitive to social causes, especially grassroots movements and had visited Temacapulín several times in years prior. In early 2019, the head of the natural resource's ministry (which Conagua is part of) visited Temacapulín and declared that destroying the towns and relocating the communities would be foolish. During his visit, representatives of the grassroots movement, aware of their low technical capital, highlighted the need to develop alternatives to the Zapotillo dam. As a result, the minister co-organized a stakeholder workshop with the grassroots movement in Mexico City to discuss and analyse alternatives to the Zapotillo project. This was only possible through their increased economic and relational capital by raising international funds to invite technical experts and allies working within the federal government. In late 2019, the first author participated in two workshops and a public media event organized by the Ministry of Natural Resources, dam-affected communities and IMDEC, and attended by more than 20 international and national organizations to discuss alternative solutions and democratize the water management regime.

Later that year, the President attended a private meeting with representatives of the dam-affected communities and the Observatory to discuss the case. Members of the Temacapulín movement recall a markedly different approach than previous authorities. Now, they would actively listen to their grievances without interrupting them and empathise with their situation. For the first time, grassroots movement members were optimistic about the government and willing to engage in governmental initiatives. At the end of the meeting, the President reaffirmed his commitment to resolving and even transforming the conflict: “The [dialogue] tables can start by asking an explanation from Conagua, which will provide all the scientific and technical information; another table would be to present the civil society's alternatives [...] The legal dimension is important, but the most important thing for us is the social dimension and water management. We will not pressure you into anything; we want you to listen to the other party and the other party to listen to you, and we all listen to each other” (12/08/2019). The involvement of the President in opening up an official space to discuss alternatives increased the social capital of the grassroots movement in the political arena.

During the first workshop, three alternative solutions were discussed from the ground up: improving groundwater management, decreasing non-revenue water, and developing household rainwater harvesting systems. In this context, the first author presented results of a quantitative model with a scenario that consisted of a set of alternatives for Guadalajara and León, which drew attention to the possibility of implementing multiple strategies instead of using only one strategy (i.e. supply augmentation through the Zapotillo project) (Godínez-Madrigal et al., 2019b). The media exposure of this socio-technical strategy shook the government of Guanajuato and the association of businesspersons of Guanajuato, who showed their public disappointment in the federal government for publicly endorsing the workshops. Although Guanajuato's stakeholders did not oppose alternatives, they stated that the Zapotillo dam should be completed at a height of 105 m. The State of Jalisco publicly dismissed the proposed alternatives as unrealistic. However, shortly after, in a public meeting of Jalisco's College of Engineers, the water authorities acknowledged their incapacity to aptly communicate to society the importance of the Zapotillo project for the city of Guadalajara, “as engineers, we don't know how to communicate”, said a representative of Jalisco's water authority.

The meetings between representatives of the grassroots movement, the federal authorities and the President of Mexico were possible since IMDEC had developed a vast network of actors from grassroots movements, some of whom were appointed to the Ministry of Natural Resources under the new presidency. A common background and experience of them was rural development,

which is associated with ideals related to the emancipation of the poor and social justice.³ This network proved essential to drive the conflict to the next conflict period.

In November 2021, the federal government and Conagua, under the auspices of the President of Mexico, agreed to negotiate with the grassroots movement by putting on the table the infrastructural change of the Zapotillo dam to protect the communities from flooding. The grassroots movement established an international technical support team to advise them at every step of the technical negotiation process with Conagua. The grassroots movement rejected an initial offer for the dam to be operated at a maximum height of 60 m using automated dam control equipment. The grassroots movement bid a counteroffer, namely to retrofit the dam with spillways at 40 m height to protect the communities even under a 10,000-year return period flooding event. To the dismay of Jalisco's and Guanajuato's governments and the surprise of the grassroots movement, the President and Conagua accepted this alternative.

In a meeting held in Temacapulín where the President and all the federal ministers of the administration were present, the communities publicly expressed their 16-year grievances. They emphasized that this was their triumph, not the government's. Moreover, the government offered a public apology and promised no repetition whilst working on a reparations plan for the communities and an environmental restoration and protection plan for the Verde River basin. This agreement means that the volume of water available to transfer from the dam will be significantly reduced. Consequently, León will not receive a water transfer, and Guadalajara's allocation will be halved.

However, although accepting this agreement protected the communities, which was the main objective of the grassroots movement, it also limited their framing and activism of bringing about "the water revolution" in Mexico. Some academics criticized this pragmatic position. However, some members of the grassroots movement's network, like IMDEC and other technical academics, continued the process for a just and sustainable water management transition. They are currently working with the water utility of Guadalajara to experiment with technical solutions to reduce the physical losses in the city's water distribution system. Meanwhile, rainwater harvesting solutions have also expanded in both Guadalajara and León. An initial socio-technical process to develop long-term water planning based on ecological conservation and restoration of the water cycle in the Verde River basin that would increase the lifespan of the Zapotillo dam as a water supply source for Guadalajara is led by representatives of Temacapulín, Acasico and Palmarejo and supported by accompanying scientists.

5. Discussion

The analysis of the Zapotillo conflict through the lens of actors accumulating capitals at social interfaces located in social arenas and opposing constellations provides a more grounded picture of which mechanisms explain the outcome of the conflict and its relevance to understanding the conditions for an actor-driven socio-technical transition. The case uncovered social and technical dynamics often backgrounded by the main approaches that study water conflicts and grassroots movements, like political ecology. First, the dynamic agency of actors in a conflict can be expressed and is reflected in the accumulation or depletion of their capitals over time at the interfaces in various social arenas with actors in dominant or challenging constellations. We argue that, in this case, the niche constellation powered by the grassroots movement's strategic mobilization of capitals is what drove the water conflict to foster a sustainable and just water management transition (Fig. 3). Therefore, water management transitions can start from the most unlikely of actors, and conflicts can have a generative dimension by opening windows of opportunity to foster a sustainability transition. Second, the conflict's evolution and actors' position in a social field according to their capitals are not linear. There are qualitative ruptures in the power dynamics between the niche and regime constellations that abruptly change actor positions in the social field. Actors can leverage key capitals that create these ruptures through critical moments at the interface between constellations and some arenas.

Here, we elaborate on these two points to discuss the contribution of an actor- and practice-oriented approach to the analysis and understanding of water conflicts and the transitions literature.

In the Zapotillo case, four conflict periods emerged from these interfaces. The first was when the government started the dam's construction, to the villagers' surprise and incredulity. Despite the immediate threat, the villagers only opposed the project two years after the start of the construction. A practice-oriented analysis of capitals, visualized in Fig. 3, shows that this tardy reaction was due to the inevitable capital disparity between the government and the villagers. The government deployed social, legal, political, economic, relational and technical capitals in the political arena that overwhelmed the villagers with legal mandates, machinery, promises and assurances that the villagers could not contest. Other practice-oriented studies on social movements have described a similar situation when "ordinary" people encounter politicians or other people with a high accumulation of capitals (Velasco-Yañes, 2000). People with few capitals would feel overwhelmed and may unjustifiably trust the former.

The event that tipped this initial position was the announcement of changing the dam's height from 80 m to 105 m, which provided no technical possibility to save the three villages. We argue that this does not constitute a different conflict period since both actors' capitals remain the same. Only the communities' positionality changed. The social movement deployed strategies to acquire social and legal capitals to establish their legitimacy as a just cause. They organized several demonstrations at the dam construction site and in Guadalajara to do this. External actors undertook significant actions, like the Commission on Human Rights and the NGOs supporting the grassroots movement. Thus, the main arena for the social movement was public opinion.

A second conflict period only materialized when the grassroots movement hosted the third international meeting of dam-affected

³ In fact, the head of the ministry himself had published several political ecology books (e.g., Toledo, 2019).

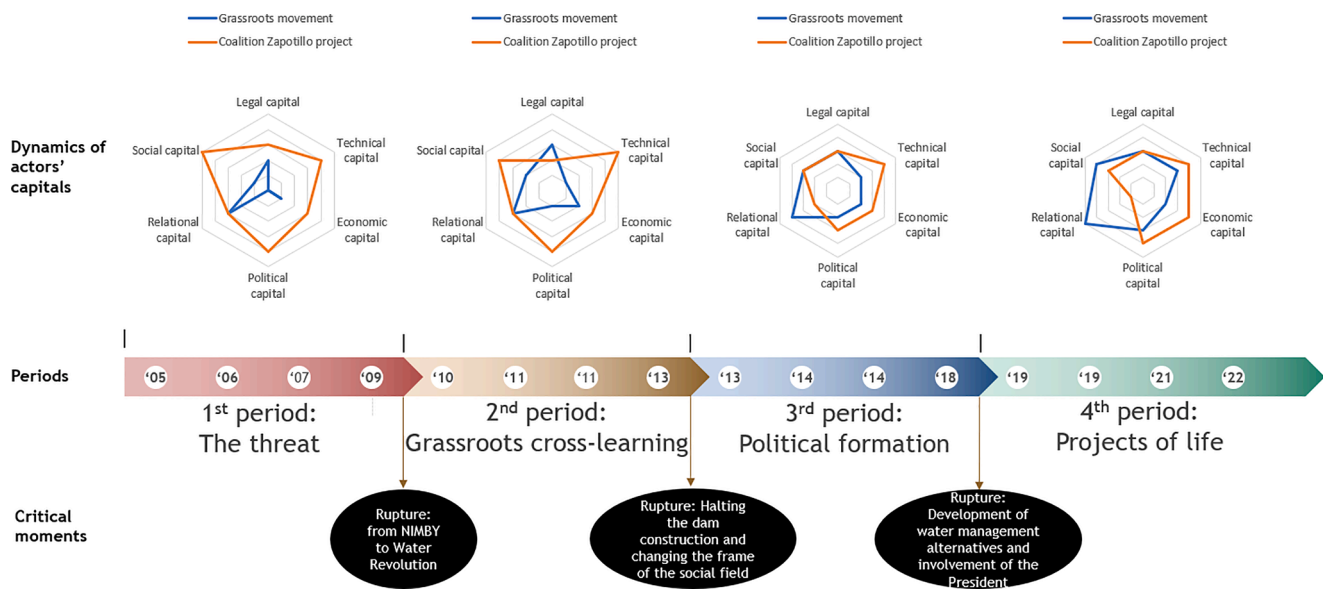


Fig. 3. The evolution of the actors' capitals in the Zapotillo conflict during the four conflict periods is detailed in [Tables 2, 3, 4 and 5](#).

communities. They mobilized their limited economic capital to deploy strategies in the relational, technical, social and legal arenas (Fig. 3). Because of that, they became a renowned movement generating newspaper headlines and advancing a legal strategy that reached the Supreme Court of Justice in Mexico, which ruled against the construction of the heightened dam. This relative safety against the dam constituted a rupture in the social field, whereby the social movement could focus their capitals on exerting a water revolution, changing their frame from NIMBY to a broader water management struggle.

The interface analysis also reveals how the capitals work with narratives that offer a new frame for understanding the social field. Fig. 3 shows the trajectory of the capitals of the grassroots movement and the government. The social capital, often regarded as the legitimacy of an actor in a social field (in this case, the infrastructural and institutional configuration of urban water supply in Western Mexico), keeps increasing over the years whilst the government's capitals decreases and stagnates. The grassroots movement mobilized its social capital to frame that the water shortages present in most cities of the country are the consequences of a corrupt, unequal, unsustainable and inefficient water management system for which the Zapotillo project was not a solution but its continuation. Notably, the transitions literature has focused on the hard factors driving change, such as infrastructure and technology (Törnberg, 2018). However, this case of frame-changing showcases how grassroots movements, as social actors, can build up cultural tension in the regime through soft factors such as favourable jurisprudence and changing public opinion. The case suggests that effective frame-changing can only occur when a newcomer's social capital surpasses that of the incumbent actor of a socio-technical regime. In the Zapotillo case, the dominant frame changed, which gave way to distinctive conflict periods in the third and fourth periods.

However, changing the dominant frame of how a problem and potential solutions are socially perceived is not enough to exert material changes (understood as objective results in arenas with direct implications in the reconfiguration of the social field, see Fig. 2) in the socio-technical system. Mobilizing additional relational, technical, economic, and especially political capitals was necessary to drive those necessary material changes (Table 6). The Zapotillo case required windows of opportunity, as suggested by Huitema & Meijerink (2010); in the political arena, a newly elected President of Mexico represented this. Moreover, the role of politics and negotiation capacity was crucial to land an agreement with the communities by looking after the interests of affected actors (i.e., Jalisco and Guanajuato governments), as Meadowcraft (2011) argued. The President needed to manage the opposition faced by the state governments of Jalisco and Guanajuato to a potential agreement with the dam-affected communities. The President agreed that the city of Guadalajara would still receive considerable volumes of water even after the intervention to retrofit the dam to a lower height. And because the water transfer to León was cancelled, Conagua is currently surveying infrastructural alternatives with the Guanajuato government. In that way, the President of Mexico acted as a political intermediary, facilitating some water management transition processes and strategies supporting Mexico's current water management regime.

Regarding the role of undone science in the Zapotillo conflict, the importance of technical capital intensified between the third and fourth conflict periods after the UNOPS fiasco. In the third conflict period, the role of controversies in the knowledge arena became prominent since they undermined the social capital of the coalition in favour of the Zapotillo project. As a result, the government of

Table 6

Comparison of major changes in the water management regime as a consequence of the grassroots movement advocacy and the Zapotillo conflict.

	Previous regime	Regime in transition
Water management institutions and decision-making practices	Arbitrary decision-making, simulated public participation, aggressive use of power, ignoring legal procedures, and resorting to imposition practices like constructing the dam before obtaining legal consent from local stakeholders (<i>fait accompli</i>).	Enhanced accountability via stakeholder involvement and co-decision-making using the Citizen Observatory for Integrated Water Management. A future challenge is to restore its diminished legitimacy. Post-Zapotillo conflict, Mexico's Supreme Court established a development project protocol to address human rights violations (SCJN, 2015).
Knowledge production practices	Centralized techno-managerial approach to knowledge production, where state-certified experts (working for Conagua and IMTA), mainly in hydraulics, lead science-policy processes	The Mexican National Commission of Science and Technology underwent a reform to include humanities and co-produce knowledge with local communities, addressing national challenges. Using the Zapotillo conflict as a flagship example, ongoing transdisciplinary water knowledge is co-produced and adopted by society. The science-policy process for a decree on basin conservation incorporated local knowledge, ensuring a holistic approach beyond hydraulic engineering. Future challenges include institutionalizing these practices in water authorities' action protocols.
Ideology: objective function of the water management regime	Policy narrative based on water security with an exclusive focus on developing water resources to supply an increasing urban water demand.	Policy narrative at the national government based on integrated water management, focusing on sustainability and social justice. A current and future challenge is that the Jalisco and Guanajuato state governments are still considering supply augmentation strategies.
Infrastructural aspect of the socio-technical system	Cities with inefficient water management and distribution practices rely on external and over-exploited sources for their water supply.	Retrofitting the Zapotillo dam with spillways at the 40 m mark involves cancelling León's water transfer, reducing Guadalajara's projected water supply by over half. With limited options for other water transfers, both cities must reconsider their urban water systems. Government-supported alternatives include implementing numerous rainfall harvesting systems in Jalisco. Future challenges include effectively implementing a water demand management strategy and ceasing additional supply-augmentation projects.

Jalisco involved UNOPS to increase their technical and social capitals by having an international actor (just like the grassroots movement) weighing on the feasibility of the Zapotillo project. However, since the grassroots movement had already started to change the conflict frame, UNOPS researched a question without social capital related to optimising the Zapotillo project. Instead, the emerging new frame of the conflict demanded a research question related to comparing the efficiency of alternative solutions to the Zapotillo project (Godínez Madrigal et al., 2020). That was precisely what dominated the research agenda during the fourth conflict period. This shows the strategic dimension of knowledge, as Hess & Belleto (2022) discussed, and how research agendas' impacts are determined by a larger configuration of actors, frames and their social capitals. With a vast network backing them, grassroots actors learned technical concepts of water systems. They handled academic concepts to propose new alternative solutions to mitigate water scarcity for Guadalajara and León. Furthermore, they are currently advocating for basin preservation to prevent a high sedimentation rate of the dam and increase its lifespan.

The challenges of a practice-oriented analysis come from the immaterial nature of some capitals. Although some capitals are easier to measure and follow through time, like economic capital with money sources, relational capital with a network analysis, etc., immaterial capitals, like social capital are much more challenging to analyse and measure. It is even questioned in literature if it can be measured at all (Robson and Sanders, 2009), although Bourdieu also indicates the importance of the amounts or quantities of capital required to dominate a field (Bourdieu, 1998). In this research, we opted to acknowledge the actors' perceptions through semi-structured interviews and following an increasing/decreasing dynamic of social capital during the four identified conflict periods. However, further research on social movements and water conflicts can take on the challenge of measuring actors' social capital through the Delphi method, which collects and systematizes expert opinions on issues. In this same venue, an interesting research question is whether one actor's capital accumulation is inversely proportional to another actor's capital depletion or if capitals dynamics are independent among actors. A theoretical question for further research is to analyse actor-driven transitions through the multiple stream's framework (Kingdon, 1995).

Another direction for future research is exploring the concept (and measurement) of spiritual capital, which was foregrounded by Velasco-Yañez (2000) in the study of social movements, Ochoa-García and Rist (2018) in water conflicts, and Wolf (2008) and Ramawadh et al. (2023) in water peace & conflict studies. Velasco-Yañez (2000) realized that many social movement members undergo personal transformations that allow them to be more resilient and persistent in the face of uncertainties, setbacks and long-term challenges. Wolf (2008) emphasised the pivotal role of spirituality in conflict transformation. The case of the grassroots movement of Temacapulín also shows that, through strong spiritual leadership, social movements also increase an unfettered hope capable of mobilizing people and resources, internal trust among its members and overarching social change aspirations that can lead to transitions. A final suggestion for further research is to explore how a water management transition would play out on the ground when most urban water systems in Mexico are characterized by overlapping water management regimes (Van Welie et al., 2018).

6. Conclusion

This paper analysed a complex and emblematic water conflict to empirically map dynamic processes and mechanisms of transition in a water management regime. It did so through a longitudinal study of social interfaces that created ruptures in the Zapotillo conflict in Mexico where actors, especially members of the grassroots movement, have iteratively interacted and developed different capitals to influence the social field of the infrastructural and institutional configuration of urban water supply in Western Mexico. Our analysis distinguished four distinctive conflict periods emerging from these ruptures where actors' strategies yielded different accumulation of capitals, reconfigured the power asymmetries between niches and the regime and influenced the framing of the social field. This analysis provided a more grounded and complex understanding of the dynamic nature of water conflicts and their relation to just and sustainable transitions in water management systems.

An actor- and practice-oriented approach can fill knowledge gaps in political ecology and transition studies. This approach focused the analyses not on structural conditions determining actors' positions, neither on a voluntarist view of decision-making and power relations, but on the actors' heuristic strategies and practices about the distribution of power, relationships, and material conditions they are trying to change. In that sense, actors do not freely mobilize capitals; instead, heuristically, they strategically discover through trial and error which capitals have more potential to influence the social field by reconfiguring the power asymmetries between the niche and the regime and investing resources (other capitals) and devise strategies to accumulate more of those kinds of strategic capitals. Actors learn to navigate a complex network of relations, meanings, resources, status and reputations. Through such continued experience, they can enrol other actors and change the framing of the social field to exert institutional and material changes leading to a desired transition.

This paper also contributed to literature on socio-environmental conflicts, which are dynamic processes that produce uncertainties, alter the status quo, and even produce more problems (Yuana et al., 2020), but they also create opportunities for change. Because of that, it becomes crucial to further study, through an actor- and practice-oriented approach, the processes and mechanisms that foster actors, albeit sometimes unlikely actors who can later form grassroots movements, to channel those uncertainties and chaotic processes to drive just and sustainable transitions.

This case study has deep implications for understanding how, in water conflicts, grassroots movements play a crucial role in transforming their resistance into a water management transition. Understanding power nuances, actor dynamics, and diverse strategies sheds light on transition patterns in social fields, contributing to broader societal changes. As the number of socio-environmental conflicts with an important grassroots component keeps increasing around the world (Martínez-Alier, 2023), the Zapotillo conflict and the social struggle of Temacapulín, Acasico and Palmarejo outlines the potential of other grassroots movements to emulate a pathway leading to not only a sustainable but also a just transition. More attention and research, especially action research through multi-actor

alliances, are needed to unveil the disguise of a miracle of grassroots movements exerting systemic change to increase the potential of unlikely, small actors in fostering just and sustainable transitions.

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CRediT authorship contribution statement

Jonatan Godínez Madrigal: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Nora Van Cauwenbergh:** Writing – review & editing, Visualization, Supervision, Resources, Formal analysis. **Heliodoro Ochoa-García:** Writing – review & editing, Visualization, Supervision, Resources, Formal analysis. **Pieter van der Zaag:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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