# Securing urban water supply through reservoir reoperation – an analysis of power resources and equity in cases from India, Spain and the USA

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# Abstract

This paper examines intersectoral water allocation, in particular how cities secure water vis-à-vis rural users, and assesses the equity of this (re)allocation. We use the distribution theory of institutional change, and argue that urban water providers mobilize power resources (positional, financial and informational) to secure water. We adapt the Institutional Analysis and Development (IAD) framework to study this empirically, with case studies from India, Spain and the United States that centre around a large reservoir and its reoperation. Results show the importance of financing power in all cases, and also suggest that cities may lack the positional power needed to implement drinking water priorities. Findings also reveal the diversity of local equity logics that justify rural to urban reallocation, and trade-offs across universal equity principles. Finally, it is fruitful to study power and equity together, as the former generally has profound distributional and procedural implications which are at the heart of equity.

**Keywords:** water allocation: power resources; equity; reservoir reoperation; institutions

# Introduction

Urbanization is a defining feature of human activity over the past century, with significant implications for the delivery of a reliable water supply [1]. By 2050, over two thirds of the human population will live in cities, and 1 billion of these urban dwellers will live in water-stressed cities [2]. As municipal water providers look for ways to meet future water needs, many will increasingly rely on water reallocation and transfers away from rural uses, as cities are generally incapable of meeting their water supply needs within their own territory [1,3]. Rural to urban water reallocation is being further driven by climate change, which affects the timing and location of water, with implications for per capita water availability [4].

In this article, we argue that water allocation is political, and that differential power resources between actors strongly influence allocation outcomes. Water allocation is the result of decisions, rules and commitments about water that require political support to be implemented [5,6]. Moreover, water allocation reflects wider social relations of exchange and access (e.g. socioeconomic class, ethnicity) and the historical patterns of these relationships [7]. Many factors outside of the water sector shape these relations such as social policy, racial relationships, colonialism, gender, spatial development and zoning, and infrastructure, among others [5]. Allocation defines who has rights to do what, when and how, raising important questions about justice [8].

To study the power behind allocation decisions, we employ the notion of power resources [9] as an independent variable across three diverse case studies, studying positional, financing and informational power of urban water providers. In each of the case studies, cities secure additional water allocations through the reoperation of a nearby reservoir: the city of Jaipur (India) through the Bisalpur Reservoir, the city of Zaragoza (Spain) through the Yesa Reservoir, and cities of the Front Range (USA) through the

Colorado Big Thompson Reservoirs, with varying implications for other, pre-existing users. The reservoirs are located in regions with an agricultural tradition, and providing water for irrigation was an original operating purpose. However over time, population growth and urbanization have necessitated more water for nearby cities that comes (at least in part) through surface water reallocations from the reservoir.

Secondly, we analyze the urban water allocation in terms of rural-urban equity – a theme which evokes a wide range of perspectives in the literature. On the one hand, there is a focus on the injustices towards rural communities, which have been referred to as 'sacrifice zones' for urban water [10], quenching the 'expanding thirst of cities and industries' at their own expense [11]. Water transfers have been understood to result from the accumulation of wealth in cities, and the accompanying dispossession of rural communities [7]. On the other hand, some research on urban water security focuses on the necessity of transfers, in combination with other supply and demand side measures [1,4]. In an intermediary space is a focus on the intersectoral trade-offs inherent in development, and the challenges of rural to urban water reallocation under pressures of water stress, population growth, food demand and industrial and municipal development [12, 3]. From this perspective, governments and regions must decide on which sectors of society will lead development, often requiring a longer-term diagnosis of equity [12,7].

To study equity, this article considers local actors' perspectives on water reallocation, as well analyzing the cases in terms of more universal equity principles. We do this by situating the relevant actors (and their power) in the local context and showing local justifications and critiques of the rural-to-urban reallocation. In the final discussion, we also assess each of the three case studies against five 'Directional Principles' of water equity [5]. As such, the guiding research questions that frame the article are:

1) What power resources do urban water providers use to secure water vis-à-vis other rural users?
2) What are the equity considerations of local actors? How do they align with universal equity principles?

In the following section, we review the literature on access to natural resources from an institutional perspective, focusing on the incorporation of power into institutional analysis. We describe the notion of power resources, and present an analytical approach based on the well-known Institutional Analysis and Development (IAD) framework. A brief discussion of equity in water allocation is proposed with which to evaluate the urban water allocation outcome. In the Research Design and Method section we present the comparative case study and data collection approach. In Results we describe the case studies, focusing on the urban water providers, and analyzing the extent to which the three power resources were mobilized to secure water allocation vis-à-vis other users, as well as presenting the local equity considerations. Finally, in the Discussion section we summarize the use power resources by urban water providers, and apply the universal equity principles to the three case studies. We then conclude and propose avenues for future research.

## Access to natural resources, and accounting for power in institutional analysis

A considerable literature on access to natural resources is devoted to the central role of rules, or institutions, such as property rights [13,14,15]. This is also true for water allocation, which is often defined in terms of the prevailing formal institutions in a given place and time – the rules that generate licenses, permits or entitlements to abstract water [16]. Property rights are not limited to ownership of a resource, particularly in the case of water, generally owned by the state, but are most comprehensively understood as different configurations or ‘bundles’ of

rights that may include access or withdrawal rights, management decision-making rights, the rights to exclude other users, and alienation rights [17]. Like property rights, public policies can also determine the benefits that people can secure from resources, such as surface and groundwater. For example, a public policy may prioritize drinking water allocation in times of scarcity, or set minimum environmental flows on a river to protect ecosystems. A challenge is ensuring the coherence between public policies and property rights; the latter tend to be more enforceable [18]. The possibilities an actor has to access water will be determined at least in part by the prevailing rules, and their interactions [18].

Beyond rights, however, there are other factors that determine access to natural resources. In the *theory of access*, Ribot & Peluso posit that we must also consider actors' ability to benefit from things [19]. From this perspective, one considers not only the rights-based ways in which people gain, maintain and control access (i.e. through water obtaining abstraction licenses or concessions), but also other structural and relational access mechanisms like technology (e.g. infrastructure), capital (e.g. finance, equipment), markets (access to exchange relations), knowledge (e.g. expert status), and other social relationships (e.g. friendships, identities) [19]. Indeed it is not uncommon for people to hold property rights to resources that they do not have the ability or capacity to benefit from [8]. In the water sector, this perspective echoes work done on the study of water reform in post-apartheid South Africa, in which it was argued that people lack 'real' rights to water if such rights are promised in law, but denied in practice [20]. More recently, calls have been made to frame water security in terms of capabilities, or the benefits that people are able, in practice, to derive from water services [21].

How does the institutional analysis literature reconcile these perspectives? This chasm between the formal rules governing access and the reality 'on the ground' can be explained in different ways. Firstly, informal institutions, like norms, practices and local rules-in-use are

in constant interplay with the formal institutions, and may be highly influential in affecting outcomes in natural resource governance [22]. Secondly, actors may behave strategically vis-à-vis the formal rules: stretching their boundaries, adapting them to local contingencies, behaving opportunistically to benefit personally, or by ignoring them all together [23, 24]. Thirdly, institutions themselves are made - and continuously reshaped - by actors (albeit usually slowly). Finally, the formation and implementation of institutions takes place not on an even playing field, but in a political arena in which some actors are endowed with more power than others [9,23,25].

This paper builds on this latter point on the nature of power in society, and how it structures the performance and outcomes of institutions. In an important contribution to this field, Jack Knight argued that institutions are best explained by distributional conflicts, and power, rather than collective benefits or some 'pareto-superior response' to collective goals [9]. Decision-making processes are political, and they result in institutions that are good for some actors, and bad for others, depending on who has the power to impose their will [26]. In the *distributional theory of institutional change*, the bargaining power of an actor is a function of their resource provision; asymmetries in the so-called 'power resources' held by actors are the main determinants of institutional change [9]. For Knight, to exercise power over someone or some group is to affect by some means the alternatives available to that person or group.

The view of power as relation between actors resonates with the wider literature on power. A seminal definition is that "A has power over B to the extent that he can get B to do something that B would not otherwise do" [27]. According to Dahl, an actor's power consists of all the resources (opportunities, acts, objects, etc.) that he can exploit in order to effect the behaviour or sway the choices or strategies of another [27]. Similarly, relationships are central to Lukes' first two dimensions of power: instrumental power depends on the

possession of resources that are useful in shaping policy outcomes in competition with others, and structural power acknowledges that decisions are influenced by the social structures within which they are embedded [28]. Giddens also refers to reference to power resources, which are found in the structure of social systems and also via agents in the course of their interactions [29].

What are power resources? For Knight, they are a combination of actors' attributes and informal institutions, capturing the ways in which actors behave – usually strategically – in bargaining situations [9, 26]. Some examples are positional power (ability to carry out credible threats), opportunity costs (how many bargaining rounds can the actor sustain), risk acceptance (higher if holding more resources), and uncertainty (the more we discount our future the more we focus on short term gains). These and other power resources have been studied empirically in natural resource settings [30, 31, 32]. Power resources also come from the formal rules that make up the state [26]. Property rights and other formal institutions have different distributional implications, for which actors bargain based on their expected net gains from formal institutional arrangements [15]. Knoepfel, for example, studies power in political processes, such as decision-making over water, proposing 'action resources' to include law, information, organization, time, personnel, money, patrimony, force, consensus and political support [33].

In the context of water allocation, biophysical or infrastructural variables can become power resources too. Land resources where water is stored, used and managed can be a strategic resource for accessing water [7]. Infrastructure and riparian position may be important resources, as an actor with the ability to plan, construct and operate large infrastructure can create new hydro-political realities, changing the nature of competition over water resources [34]. Biophysical resources generally are important to the extent to which humans have placed use value on them [35].

In this article, we take the view that power resources can come from a wide range of social and ecological variables, however we propose to look empirically at three:

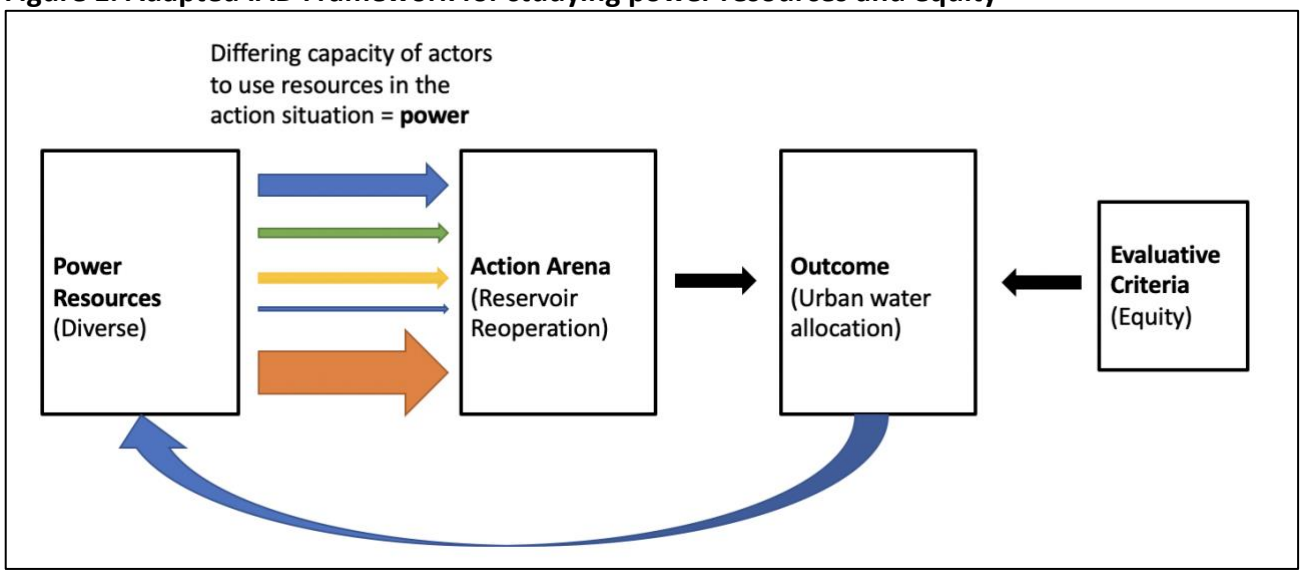
1) Positional power refers to an actor's position that allows for certain actions and certain strategies, for example how positions of authority enable actors to carry out credible threats [32]. Positional power comes about first and foremost from the relationships defined through formal institutions, but also through how actors interact strategically with their multi-positionality, due to overlap in policies and property rights, for example. In the context of water allocation for cities, we expect that urban water providers use positional power as implementation agencies for government policy on drinking water priorities, in order to secure additional water supply.
2) Financing power refers to the budgetary and financial resources available to an actor to influence decision making. Financing has been studied in transboundary water settings, in which actors use financial support to bring about compliance by other actors [34]. In the context of water allocation for cities, we expect urban water providers to use financing power to build capital intensive water infrastructure projects to secure additional water supply.
3) Informational power refers to the ways in which access to information, particularly the awareness of alternatives, is used by an actor strategically [9]. In addition, knowledge, which includes skills and expertise has proven to be important [31]. In the context of water allocation for cities, we expect urban water providers to hold superior information and knowledge about water supply scenarios, and on the governance regime, and use this strategically to their advantage to secure additional water supply.

## Analytical framework combining power resources & the IAD framework

To study the these three power resources systematically and empirically, we adapt the Institutional Analysis and Development Framework (IADF), which is frequently used by institutional scholars to relate concepts in governing common pool resources, such as water [36]. It provides a systematic way to understand institutions and actors, and to evaluate outcomes. At the centre of the analytical framework is the 'action arena' – a social space in which actors interact, such as through decision-making activities, exchanging goods and services, or engaging in collaboration or conflict [36]. The activity in the arena is shaped by biophysical conditions, attributes of the community and rules-in-use in the original IAD framework.

To incorporate power, adaptations to the IADF have added 'political economic context' and 'discourse' to the variables [37]. Others study power by using the framework to study not only action, but also inaction, non-decisions or inability of actors to influence rules [38]. In our version (Fig 1), we instead focus on power resources, and cluster all of the exogenous variables together into this broad category. This is done to capture the myriad types of power resources that can potentially be used by actors to influence decision-making, discussed in the previous section. The ability of actors to bring these diverse resources into the action arena is our version of power. Actors' power resources are relative to others', and are leveraged in cooperative or conflictual logics [39,33]. In some cases, the actors with the most power resources at their disposal have more ability to coerce others (i.e. more possible tactics and strategies) than those with fewer (i.e. fewer options, less manoeuvrability) [34]. But this is not necessarily the case; it remains an empirical question [9,33].

**Figure 1. Adapted IAD Framework for studying power resources and equity**




In the subsequent empirical analysis, our adapted IADF is used to conceptualize the variables (positional, financial and informational power) that an actor (urban water providers) can bring into the action situation (reservoir reoperation events). The outcome is fixed and shared across the three case studies: urban water provides secure additional water allocation. We use the IADF to look *a posteriori* at what power resources were influential in reaching this outcome, and if there are observations that can be made across the cases. We then assess this outcome in terms of equity.

## Evaluative criteria: equity

Evaluative criteria in the IAD Framework are used to determine which aspects of the observed outcomes are deemed satisfactory, and which aspects are in need of improvement [36]. Water allocation can be evaluated from many different perspectives including sustainability, efficiency, security, acceptability, or equity [40]. We focus only on equity, and more specifically the question of equity across the rural-urban interface. In other words: is it *equitable* that urban areas have secured these water resources, vis-à-vis the other, pre-existing, rural users of the reservoir water?

To operationalize the study of water equity, there is a strong sense that it must be understood in its local context [11,41]. What is considered equitable in water allocation can be highly context-specific, linked strongly to local culture, social structure and history [7]. Moreover the context can change over time. For example, prior appropriation (or 'first in time first in right') in the Western USA was initially was designed to protect legitimate water users against capitalists who would accumulate water rights, but in its present incarnation represents a barrier to equity reform [42]. This perspective echoes Amartya Sen's conception of justice more broadly, which suggests that claims to universal justice principles in a hypothetical world are not of much use in addressing equity issues in practice, and instead it is important to recognize the plural nature of justice [43]; individuals themselves, not only different societies, may have differing conceptions of justice that comprise a sort of spectrum.

On the other hand, it is also important to find common 'core issues' that can transcend localized understandings of equity; approaches that are locally-legitimate, allowing for specificity and diversity, but that also enable a shared language of justice [7,44,45]. As such, we provide a cross-cutting discussion of the cases, using Wilder and Ingram's 'Directional Principles' on water equity [5]. There are 5 principles (displayed in Table 1): the common good, consideration for non-humans and future humans, inclusive procedures, sharing burdens, and addressing power imbalances. The Directional Principles were designed to "point in the direction in which water policies must move to serve fairness as contexts and circumstances change" [5].

**Table 1. Directional Principles on water equity** [5]

| **Directional Principle** | **Water policy is moving in the right direction when….** |
|---|---|
| Common good | Water is treated as a common good that serves multiple values and is not reduced to mere property or an economic commodity that serves utilitarian purposes |
| Considerations of non-humans and future humans | It is mindful of the needs of non-humans including plants, animals, places and habitats as well as the inheritance of humans in future generations not yet born; Each new |

| | |
|---|---|
| | generation is being socialized into making equity judgments and spaces exist to reconsider or reimagine the practice of water equity over time. |
| Inclusive Procedure | Decision making processes are open to broad participation of all affected parties including through such things as networks, voluntary associations and public private partnerships; and procedural justice is as important as making fairer water allocation and distributional choices. |
| Sharing Burdens | There exists not only shared allocation of rights and benefits but also shared risks and burdens associated with population growth, climate change and emergent technologies. |
| Addressing Power Imbalance | Imbalances in political and economic power are being redressed rather than simply reproduced in water policy. |

# Research Design and Method

A comparative case study approach is used to investigate three cases of reservoir reoperation [46]. The cases are delimited in time by the beginning and end of the reoperation event, and spatially by focusing on user groups using water directly from the reservoir and stakeholders related directly to the reoperation. The cases have the same outcome (urban water allocation from a shared reservoir), and share some contextual variables such as climate (semi-arid), social and ecological pressures (climate change and urbanization), and infrastructure (large, man-made reservoirs). However there is significant variation across the cases in terms of social and governance variables, such as water allocation institutions and actor configuration. This makes the research design akin to a *most different systems* approach to reflect the diversity of governance dimensions that may contribute to the outcome [47].

Qualitative data was collected between 2018-2022, including 15-day on-site visits to each location (Colorado and Aragon in 2018, Rajasthan in 2019) where semi-structured interviews with stakeholders took place, as well as guided site visits to the reservoirs. Actors in our research are decision-making entities such as organisms, collectives, user groups, government departments. Approximately 20 interviews per case were conducted – mostly on site, and some by phone. Key actors were identified in advance of fieldwork, and snowballing on site provided a complete roster of relevant actors to the reoperation. The first part of interviews followed a traditional, semi-structured approach, posing open questions by topic.

The second half of interviews involved collecting participatory network data, in which research participants provide their own description of actor relationships [48]. Practically, the method involved proposing the interviewee a blank piece of paper in which their organization was written in the centre. Through discussion, the interviewee and researcher link the organization to all other actors with whom they exchanged during the reservoir reoperation. Exchanges were classified terms of authority (e.g. organizational hierarchy), financing (i.e. budget flows, financial aid, project funding) and information sharing (i.e. formal reports commissioned or shared, informal dialogue) and recorded visually on the map by colour-coding the different relationships.

Interview transcriptions and participatory network maps were then used to study power resources systematically across the cases, as guided by our analytical framework (Fig 1). Power is challenging to study empirically; whereas some authors address this challenge by focusing on perceived power [31], we focus on power resources that are relatively visible and easily observed [49], and moreover that can be verified and triangulated with secondary data sources. Our main assumption is that we can interpret the actions and strategies of actors during the reservoir reoperation event as expression of their power resources.

# Results

In this section, we present each of the reservoir reoperation case studies (summarized in Table 2). We begin with a general description of the city's demand that led to reservoir reoperation, and the rural-to-urban water reallocation it implied. We then turn to focus on our main actor – the urban water provider – and analyze their strategy in terms of positional, financing and informational power. Finally, we summarize some of the local rural-urban equity concerns that emerged from interviews.

**Table 2. Summary of reservoir reoperation cases**

| Case Study | Bisalpur Reservoir | Yesa Reservoir | Colorado Big Thompson Reservoirs |
|---|---|---|---|
| **Action arena** | Decision to connect mega city Jaipur to the reservoir via 120 km pipeline | Memorandum of Understanding to connect Zaragoza to Yesa reservoir for urban water supply (signed in 2001) | Gradual transition of water rights and use from agriculture to urban municipalities |
| **Water use prior to reoperation** | Irrigation for Tonk District & municipal supply for towns of Ajmer District (since 1994) | Irrigation for Bardenas community of irrigators (since 1956) | Reservoirs originally providing water for agriculture along the Front range (since 1954) |
| **Time period of analysis** | Discussions begin 1999, pipeline complete 2009, analysis up to 2019 (fieldwork period) | Discussions begin in 1992, MoU signed in 2001, analysis up to 2018 (fieldwork period) | Transfer of rights begin in 1960s, continue to present, analysis up to 2019 (fieldwork period) |
| **Urban water provider** | Public Health and Engineering Department (PHED) | Zaragoza City Council (ZCC) | Municipal Corporations (MCs) |
| **Dominant water allocation mechanism** | Non-priority permit systems (no historical preference nor land based ownership requirement) | Preferential access (long-term concessions granted by river basin authority) | Water market with transferable water rights (amongst users in service area) |
| **Relevant water policies and laws** | 1999 State Water Policy<br>2005 Draft State Water Policy<br>2010 State Water Policy | 1985 National Water Law<br>2000 EU Water Framework Directive<br>2004 Aragon Principles of Water Policy | 1876 Colorado Constitution<br>1973 Water Conservancy Act<br>2015 Colorado Water Plan |

# Case Study 1. Bisalpur Reservoir

Since 2009, the city of Jaipur in Rajasthan, India, obtains drinking water from the pre-existing Bisalpur Reservoir, located 120 km away on the Banas River – an upper tributary of the Ganges. Jaipur is the most populous city in the state of Rajasthan, with over 3.5 million residents, and a population growth rate of 17 – 20% per decade. Having depleted the nearby Ramgarh Reservoir, and with an ongoing groundwater crisis, the Bisalpur Jaipur Water Supply Project (BWSP) was designed to allocate water from the existing storage in Bisalpur (full capacity of 1100 MCM) to supply an additional 360,000 m3/day for Jaipur city and 40,000 m3/day for villages situated along the pipeline. Prior to this, and since its construction in 1999, the Bisalpur reservoir provided irrigation water to Tonk district (a command area of approximately 80, 000 ha) and municipal water to the towns of Ajmer, Kishangarh, Beawar, Kekri, Nasirabad and Sarwar.

The implications of the Bisalpur reoperation have been that Jaipur obtains approximately half of its municipal supply, or 275,000 m3/day from Bisalpur, and that all other users have experienced a reduction in their allocations. Since 2012, water releases to irrigation have stopped entirely, and Tonk continues rainfed production only. The reasons for reduced allocations are the significant new demand Jaipur places on the reservoir, but also a reduction of inflows to the reservoir observed over the last decade due to climate change and upstream water management. Municipal water demand significantly exceeds available supply most years, and all cities (including Jaipur) regularly face curtailments in their supply from Bisalpur (e.g. of 30% during the 2019 fieldwork period).

### *Power resources – position, finance and information*

The urban water provider for Jaipur is the Public Health and Engineering Department (PHED). They are a fully public department, responsible for urban and rural drinking water supply for the entire state of Rajasthan. Whereas in other parts of the state, implementation of drinking water projects is devolved to other local management units, for Jaipur the PHED is directly responsible for planning, designing, building, operating, maintaining water infrastructure, as well as quality monitoring and billing.

In terms of position power, to implement the BWSP an interdepartmental agreement was made between the PHED and the Water Resources Department (WRD), with the consent of the Government of Rajasthan (GoR). The WRD owns the reservoir, as the agency responsible for the collection and storage of water resources in the state, and also issues water permits to different user groups. Water permits are decided on as an administrative decision of government, based on prevailing policy, on water demands, and on knowledge of the hydrological system - there is no weight given to historical use rights nor land ownership. Through this agreement, the PHED secured additional water rights to Bisalpur Reservoir.

The 2010 State Water Policy for Rajasthan is unequivocal in prioritizing drinking water over other uses: “Drinking water needs of humans and livestock will be the first charge on any available water sources. In multipurpose irrigation projects top priority will be given to drinking water.” As water is a state-level competence in India, the GoR is the main authority, and develops policy with the State Water Resource Planning Department that is directly executed by PHED and the WRD. The PHED is thus directly accountable to the GoR in implementing state water policy, and they are also the operator of the reservoir as its main user, delivering water to cities, towns and villages. As such, positional power was key to PHED’s ability to secure additional urban water supply from Bisalpur.

In terms of financing, the PHED has limited resources of its own to invest in capital or operational works; they recover as little as 2% of their costs from user charges. Much of the population accesses water through illegal connections and boreholes, and those connected to the municipal supply are seldom monitored or metered. Water supply in the city and in the towns and villages is intermittent, which further decreases users willingness to pay. As such, most of PHED’s budget comes from state and central government schemes, external aid, and GoR budget allocations.

For the BWSP, funding came multilateral development banks. Loans were provided by the Asian Development Bank for the pipeline, and by the Japan International Cooperation Agency for the urban distribution network in Jaipur. Sovereign-guaranteed loans were formally requested by the GoR on behalf of the PHED, and passed down from the Government of India to the GoR, then the PHED. The scale of the urban demand in Jaipur, and the fact that the PHED operates in an almost continuous crisis mode to provide basic drinking water necessitated this external aid. As such, the PHED leveraged more of a ‘financial support’s resource to secure water, as opposed to leveraging their own capital.

Finally, the PHED does not mobilize any particular informational advantage in securing additional water from Bisalpur. Knowledge and expertise came exclusively from the WRD, based on internal expertise on hydrology and civil engineering. The development banks did not include any technical assistance, nor were any outside consultants involved.

### *Local equity perspectives*

The demand placed on the Bisalpur reservoir by the city of Jaipur has exacerbated the zero-sum dynamic: additional water for one user group means less for another. There is no compensation provided to farmers, whose allocations from Bisalpur ceased in 2012. However, given the severity of the drinking water crisis in the region, most actors interviewed from across different sectors consider the water reallocation to Jaipur, including the lack of compensation for farmers, justified in order to meet basic drinking water needs. The allocation priority in the 2010 State Water Policy was frequently referred to by public officials and NGOs, underlain by a sense of crisis. One authority shared: "We have a government duty to provide 135 litres per capita per day, which is the Indian Standard. With the population growth rate in an arid state, what are we to do?"

Rural-urban equity concerns evoked by local stakeholders centre instead around two main issues: PHED's duty to provide rural – not just urban - drinking water, and on the need for upstream-downstream coordination. During the construction of the pipeline, villagers violently protested the lack of planning for rural drinking water supply. As a result, PHED obliged construction companies to engage local NGOs, and to provide public stand posts along the pipeline for villages in Nevai, Tonk, Chap, and Malpura. However rural supply has been intermittent and unpredictable, creating an untenable situation for the villages, considered unfair. In contrast, upstream of the reservoir rural water supply has been prioritized through rural development programs such as *Jal Swavlamban Abhiyan* that

advocate for farms and villages to store water locally in anicuts - small check dams. For some stakeholders, such programs are essential for rural livelihoods, and could also play a role in recharging groundwater and supporting the sustainability of the social-ecological system [50]. Others argue, however, that these programs work against PHED's and WRD's immediate efforts to improve the dependability of Bisalpur, being partly to blame for the reduced inflows into Bisalpur reservoir in recent years (though climate change is also widely acknowledged as a driver).

## Case Study 2. Yesa Reservoir

Since 2009, the city of Zaragoza obtains 80% of its drinking water supply from the pre-existing Yesa Reservoir, located 150 km away on the Aragon River - an upper tributary of the Ebro. Zaragoza is Aragon's most populous city, with 700,000 inhabitants. Traditionally their water supply came from the mainstem of the Ebro, via the Imperial Canal, but by the 1990s, city authorities recognized the extent of water contamination from agriculture, with high concentrations of salts, nitrates and other suspended matter. In addition, the population was expected to grow to 1 million in the coming decades, driving the need for a higher-quality, reliable water source. A 2001 Memorandum of Understanding (MoU) between the city and the basin authority outlined the conditions for a new allocation from Yesa, which became nested in a larger 2004 decision to expand the reservoir capacity from 450 hm3 to 1079 hm3 for irrigation and municipal purposes. Prior to the reoperation, Yesa was exclusively used by the Bardenas irrigators (*Comunidad General de Regantes del Canal de las Bardenas* in Spanish), for 80,000 ha of cereals and orchards. The implications of the reoperation have been a clean, dependable water supply for the city, as well as 47 smaller towns and villages, and there have been no reductions in the delivery of water to the Bardenas irrigators.

### *Power resources – position, finance and information*

The urban water provider is the Zaragoza City Council (*Ayuntamiento de Zaragoza* in Spanish, hereafter ZCC). They are a fully public utility, responsible for water regulations and by-laws in the city, for metering, rate-setting and billing. In terms of their positional power, however, they are a water user in a confederation of basin users, with no particular authority to assert their priority for drinking water. The central actor is the basin authority itself, the Confederación Hidrográfica del Ebro (CHE), which issues formal authorizations to abstract and use water in the form of concession contracts. Whereas regional governments (Autonomous Communities) have jurisdiction over rivers located entirely within their territory, rivers that extend through more than one jurisdiction, like the Ebro, are under responsibility of the Central State, largely through their representation in CHE.

In 2001, the ZCC entered into a MoU with CHE and the Autonomous Community of Aragon to secure access to high-quality drinking water from Yesa, with water quality as the main driver. The newly-established EU Water Framework Directive prescribed drinking water quality requirements for member states. Moreover, a provision in the 1985 National Water law prioritizes drinking water over industry and agriculture. These formal institutions could - in theory – have given positional power to ZCC to assert their institutional water priority, but in practice this was not the case. The MoU did not grant full water rights to the city, but specified an elaborate 3-phase project through which the city would eventually secure their priority access (*demande preferente* in Spanish) – to water from Yesa. Until then, priority allocation from the reservoir remains with the Bardenas irrigators (as was still the case during fieldwork in 2018).

Financing power played an important role in in each of the phases outlined in the MoU. To use the private irrigation canals to transfer water to the city, Phase I required the ZCC to pay the Bardenas irrigators an annual use fee. For Phase II, ZCC committed to

constructing a small regulation reservoir, leveraging funding from the EU Cohesion Funds and from the central state. Finally, Phase III required the city to co-finance the Yesa regrowth project, to secure priority access. Moreover, the ZCC pays an annual consumption fee for 132 hm3 of water, but only uses 60 hm3. This is due to extensive urban water efficiency projects, and the fact that the population growth stabilized at 700,000 instead of growing to 1 million as expected at the time of the MoU.

Finally, informational power was not notably mobilized by ZCC to secure water supply. Information on both supply and demand in the basin is centralized by CHE, and is accessible to all basin users. *Lack* of information on the wider social and political context, however, can explain at least in part how the ZCC got involved in such a large and controversial project. Water demand for the city had been overestimated, a lack of alternatives for water supply were explored, and a lack of due diligence into the potential social and ecological impacts of the Yesa regrowth all contributed to ZCC's eventual involvement in the project.

### *Local equity perspectives*

Zaragoza's use of Yesa has not decreased water availability for irrigators – on the contrary, water allocation to irrigation is positioned to significantly increase once the Yesa regrowth project is complete. The 2001 MoU that assured water allocation for ZCC became nested in a much larger reservoir expansion project, in line with a long-standing promise of the 1992 Aragon Water Pact to double Aragon's irrigated area (part of which will come from Yesa). As such, a major equity issue for many local actors is that Zaragoza has paid too high a cost for this water supply, both financially, but also through their association with an engineering project which has engendered significant social and environmental impacts, and huge cost overruns. While they did secure a higher-quality water supply for the city, it is well

established that their demand did not necessitate the reservoir *expansion*. With hindsight, stakeholders observe that the MoU served to bolster the demand and political will for the expansion project, and to provide important source of its financing. As such, since 2015 the ZCC has been officially opposed to the regrowth project, seeking to decouple their water use from it, and commissioning studies to find alternatives.

The irrigators understand their role - historically and at present - as important for stabilizing rural communities, for addressing the 'territorial imbalance' in Aragon as nearly 70% of the population live in the city of Zaragoza, and for contributing to local, regional and EU economies. Irrigators traditionally have strong support from the basin authority CHE, and there is a tendency to protect historical water concessions to agriculture. The fact that the irrigators financed the original distribution infrastructure from Yesa justifies, at least for some, that the ZCC pay for their priority access. An interview response sums up this point: "Until Yesa Regrowth is complete, it is the Bardenas irrigators who have priority access (…) I can't go to a neighbour's house and tell them to leave, even if I need the house more than they do, because I haven't paid for it, it's their house."

## Case Study 3. Colorado Big Thompson Reservoirs

As early as the 1960s, cities along Colorado's Front Range have been obtaining water from the Colorado Big Thompson (CBT) reservoirs, which were originally constructed and authorized as a federal irrigation project. Whereas only 50,000 people were living within the CBT service area when the project became operational in 1957, by 2020 the region was home to over one million people. The CBT project is a system of linked reservoirs that operate as a unit, located along the headwaters of the Colorado River. Three collection reservoirs and a natural lake capture water on the west side of the Rocky Mountains, and send water through a mountain tunnel to three terminal reservoirs on the east side for distribution to end users.

The implication of the gradual reoperation of the CBT reservoirs has been that municipal corporations now hold a large majority of the rights to water in the CBT reservoirs. In the beginning, 97% of CBT water use and 85% of water rights ownership was by agricultural groups. By 2020, however, only 50% of water was used in agriculture and only 30% was owned by agricultural groups. The separation of use and ownership is explained by the fact that CBT water – like water in much of Colorado – can be bought, sold and leased on a water market. Any municipal water organization, irrigation district or farmer within the CBT boundaries are allowed to buy or sell water rights from each other, or negotiate leases. In many cases, municipal CBT users lease water back to farms, which mitigates the impact of the water reallocation for irrigators [51].

### *Power resources – position, finance and information*

The urban water providers are the municipal corporations (MCs) with allotment contracts granted by the CBT project owner and operator, Northern Colorado Water Conservancy District (NW). The MCs consist of 33 cities and towns along the Front Range of the Rocky Mountains that obtain a portion of their municipal drinking water from the CBT. The main municipalities in terms of volume of allocation are cities north of Denver including Greely, Boulder, Fort Collins, Broomfield, Longmont and Loveland.

In terms of positional power, MCs have no particular advantage vis-a-vis other CBT water user groups. According to the 1973 Water Conservancy Act, requirements for all CBT allottees are the same; they must be physically located within the 1.6 million acre CBT service area, and must put water to 'beneficial use,' which include municipal, irrigation and industrial uses. Finally any new applicant must formally request an allotment from NW, and attest to the immanency of a water crisis: that "use of this water supply is essential for the well-being of the community and for the preservation of the public peace, health, and safety"

and that “an emergency exists” in meeting the applicants’ water supply. Whereas the Colorado Constitution states that priority must be given to domestic water supply before irrigation and industrial supply in times of drought, in practice MCs’ water demand is equal to all other CBT water users’.

This brings us to the primacy of financing power. As there is a finite supply of CBT units (fixed at a maximum of 310,000 acre feet per year - approximately 382.4 MCM) and demand continues to increase, the price per unit of CBT water has skyrocketed, setting national records. In 2010, sales prices ranged from 6000 to 9000 USD per unit, in 2015 from 24,000 to 26,000 USD, with evidence of CBT water trading at 60,000 USD per unit in 2020 [53,54]. Such prices make it more difficult for agricultural users to buy CBT water, and have favoured rapidly-growing municipalities and their real-estate developers who propose farmers attractive prices for their water rights. These types of transactions have come to known locally as ‘buy and dry’ as water moves from irrigated farm land to urban areas.

Regarding informational power, MCs tend to rely on brokers to negotiate transactions, but there is little transparency on these actors and on the water prices settled on for sales and leases. There is no public tracker for transactions, and those that voluntarily share details from transactions to NW are anonymized. Our research suggests that some MCs might be better connected to savvy brokers than others, which gives at least a small role to informational power. In terms of water supply, MCs have no informational advantage. NW issues a water delivery quota twice per year, quantifying the amount of CBT water available to allottees. The quota is based on hydrological conditions, storage and other supply side factors. Based on this information, short term trading and long term sales take place.

### *Local equity perspectives*

Market logic is embedded in local justifications for the rural-urban water reallocation. Many interviewees maintained that a system of willing buyers and sellers produces a fair price for water, and that water goes to its highest value use (in the monetary sense of the term). More specifically, Colorado's regulation on beneficial use and anti-speculation are understood as important safeguards that keep water markets fair. Beneficial use refers to the obligation that water rights holders show actual use; it has been argued that this remains a powerful mechanism to prevent speculation, and the concentration of control over water, and works in favour of distributional equity. Anti-speculation measures can be found in institutions throughout the state; in the CBT system, when a request to purchase water rights is made, NW guidelines limit water rights to 3 acre feet per acre for agriculture, and two times the previous year's usage for municipal use.

Rural-urban water equity has been upheld, according to interviewees, because the water market has largely enabled northern Colorado to maintain its agricultural tradition. Through 'alternative transfer mechanisms' and 'perpetual water sharing agreements', cities that own water rights put them to use during periods of drought, but the rest of the time to lease them back to farms. While the reallocation of rights has resulted in some fallowing of agricultural land, the leasing mechanism has allowed agriculture to remain the main user of CBT water in most years. Interviews suggest that in the future, the agricultural interests stated in the original authorization of the CBT project will be referred to more frequently by the NW Board in assessing allotment applications, in order to preserve the agricultural heritage of the region.

In terms of securing urban water supply, however, some government stakeholders expressed concern that there is no legal basis for intervention in water markets. One interviewee shared: "(Our department) wishes that they had the ability to allocate water

according to needs. For example some entity growing hay and using the full allocation while an urban utility is struggling to get water is frustrating. But the State cannot legally say that some uses are more important than others. It does not matter what users are using it for." In this context, municipalities are on their own in securing and financing water supply for present and future citizens. To date, the constitutional provision on drinking water priority in times of shortage remains a theoretical guarantee, and municipalities must exhaust all options before resorting to this provision. Furthermore, whereas in the past the federal government was active in building and financing new infrastructure, new water infrastructure must now be self-funded.

# Discussion

The power resources mobilized by urban water providers to secure water from a shared reservoir are summarized in Table 3. Positional power was present only in the Bisalpur case, in which the PHED – as a direct executing agency for state water policy – is in a position to implement the drinking water priority over agriculture or industry. Executing this policy is relatively simple, as water rights are granted as an administrative decision of government, promoting alignment between property rights and water policy outlining the drinking water priority. Moreover, the PHED is also the operator of the reservoir itself, further solidifying their positional power to secure water vis-à-vis other users.

**Table 3. Summary of power resources used by urban water providers to secure water**

| Power resources | Importance of power resource to securing water allocation | | |
|---|---|---|---|
| | Public Health and Engineering Department (Rajasthan) | Zaragoza City Council (Aragon) | Municipal Corporations (Colorado) |
| Position | High | Low | Low |
| Financing | High | High | High |
| Information | Low | Low | Low |

Financing was an influential power resource in all three cases, albeit in different ways. In the Bisalpur case, the PHED benefited from a financial support resource in the form of development aid from government and multilateral development banks. In the Yesa case, the ZCC pay the irrigators, the basin authority, and construction companies for an elaborate 3-phase project to eventually secure water rights to a reliable source of clean water. In the CBT case, MCs must buy their water allocation in the form of tradeable water rights in the market – with prices reaching national records in recent years. These latter two cases inform us not only about the importance of the financing power, but also how it trumps positional power where cities must first and foremost be able to pay in order to implement the drinking water priority (as enshrined in the National Water Law in Spain, and the State Constitution in Colorado). In these cases, urban water providers are not well positioned institutionally to claim water for the drinking water priority, raising questions about urban water security. In the future, in cities with similar institutional settings, it may be necessary to buffer cities' financing power and/or to address institutional interplay to ensure drinking water.

There was little evidence in the cases that informational power was important in securing urban water supply, though it played a minor role in the CBT case. Certainly, lack of complete information, and the impossibility of knowing or anticipating systemic effects, poses significant challenges for all actors involved in water resource planning. In the case of Yesa, a lack of insight into the potential problems of the reservoir expansion led the ZCC into a controversial project they would eventually come to oppose. In the Bisalpur case, the PHED relied on information collected and analyzed by the WRD, which did not foresee the reduced inflows into the reservoir due to climate change and upstream land use. Improved informational power resources could have mitigated the problems encountered in the cases.

Other power resources that were observed in the case studies, that might be fruitful for future research are partnerships and collaboration (extensive between municipal

corporations in Colorado), political support and representation (cities as large, voting populations in all cases), and patrimony (the extent to which some actors wield power to protect heritage).

Regarding the local equity considerations, specifically on the rural-urban divide, each case was unique. Only in the Bisalpur case, was there a perception of irrigators and rural communities as 'losers', and even then, many stakeholders simultaneously expressed understanding that the government drinking water priority justifies water transfers to cities. In the CBT case, sharing water through the short-term leasing options on the water market is widely understood to benefit both municipalities and farms. In the Yesa case there is ultimately no reallocation away from irrigators, they are the main beneficiaries, and the local equity issues surround the fairness of imposing large irrigation projects, and their financing, on other basin users and stakeholders.

Turning to the universal principles, the cases align to varying degrees with the 5 'Directional Principles' described in the introduction. Arguably, the Bisalpur case most reflects the *Common Good principle*, which suggests that water be "treated as a common good that serves multiple values and is not reduced to mere property or an economic commodity that serves utilitarian purposes." The government is allocating scarce water resources to where the human population is most dense, by whatever physical and engineering means possible. Water rights are not based on any historical preference, nor land or water ownership pattern, nor any explicit notion of putting water to its 'highest value' use in economic terms. Certainly, however, the extent to which the common good can be maintained under such drastic and short-sighted supply-side water projects, can be called into question [50]. It has been argued that this approach aggravates rural poverty, pushing workers to the city and its expansive peri-urban zone, contributing to rural to urban migration [54].

The Yesa and CBT cases most reflect the *Sharing Burdens principle*, referring to the existence of "not only shared allocation of rights and benefits but also shared risks and burdens associated with population growth, climate change and emergent technologies." In the Yesa case, the basin authority CHE ensures water benefits must be accompanied by congruent costs. For over 40 years, irrigators were the sole beneficiaries of Yesa reservoir water, and having paid for the original distribution infrastructure, the message is that any new beneficiaries have 'earn' their drinking water priority. In the CBT system in Colorado, all users and uses are equal from a regulatory perspective, with provisions in place to ensure beneficial use, to prevent harm or damage to other users, to encourage water sharing across sectors, and to financially compensate any group that permanently or temporarily gives up their water though the water market.

None of the cases reflect a strong emphasis on the other principles of *Inclusive Procedure* (though the Colorado case comes the closest with the heavy involvement of users themselves in water transactions), nor *Consideration for Non-Humans* (environmental flows are either peripheral concerns, or non-existent - as in the case of Bisalpur). *Consideration of Future Humans* could apply to the cases, in the sense that most future humans will live in cities. Finally, the principle of *Addressing Power Imbalances* is present in the cases to the extent that water policy outlining allocation priorities is on a needs or merit basis, and not on based on an actor's power. However, as we see in the Yesa and CBT cases, political and economic power is often vested in the property rights to water, which are seldom addressed explicitly or reformed by well-intentioned water policies.

This brief discussion of the cases against the *Directional Principles* reveals that not only are there diverse in-situ conceptions of equity by local actors within and across cases, but also that universal equity principles are varied, and unique from one another. In other words, equity as a concept is vast, and different notions and principles of equity are not

always complementary. Just as there are trade-offs to be made across different objectives in water allocation (efficiency, sustainability, equity, for example) so too are there trade-offs to be made across different principles within equity.

The study of power resources has been instructive for understanding local equity, as well as for categorizing the cases in terms of more universal equity. In mobilizing the *distributional theory of institutional change*, the study of the power resources can serve to identify the factors that lead to unequal bargaining power, that result in asymmetric distributional outcomes [9]. The significance of the financing power resource in these cases, for example, has clear distributional outcomes, favouring water users who are able to pay for infrastructure, and leading to the predominance of the *Sharing Burdens* equity principle for the Yesa and CBT case. The positional power of the urban water provider for Jaipur city favours water allocation users who are prioritized in state water policy – in this case to the city where drinking water needs are most concentrated, and leading to the predominance of the *Common Good* principle in the Bisalpur case. Through power resources, we generate insights into understanding processes behind distributional outcomes [9].

# Conclusion

Power resources are a valuable way to study power in decision-making settings, and also shed light on the origins of distributional outcomes. We adapted the IAD framework to study how urban water providers use power resources to secure additional water from rural areas through reservoir reoperation action arenas. Results showed the importance of financing power across the three case studies, in spite of major institutional differences. Positional power proved to be a central driver of water reallocation in the Bisalpur case study, but not very significant in the other cases where the drinking water priority does not carry the

enforcement power of water rights. Informational power was not a significant power resource used by urban water providers. Finally, we evaluated each of the case studies in terms of equity, presenting both local notions of equity that justify or critique the increased urban water allocation, as well as assessing the cases against more universal principles.

We encourage future researchers to apply the power resources approach more extensively, in terms of types of power resources studied, geographies, methods, and in terms of scale. As the focus of this article was bulk, inter-sectoral water allocation, we did not assess if and how the water reaches end users. Particularly within the urban perimeter, utilities often proceed to distribute water inequitably once they have secured the bulk water provisions. Finally we encourage future researchers to continue studying water equity with 'hybrid' approaches that consider both the local context, and with regard to universal principles. Principles enable a shared language, and reveal potential blind spots, or opportunities to advance equity for more stakeholders with a longer-term perspectives than might be possible for actors involved in more short-term decision making.

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