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Innovating resource regimes: Water, wastewater, and the institutional dynamics of urban hydraulic reach in northwest Mexico

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ABSTRACT

The twin facets of *urban hydraulic reach* – cities' appropriation of water from surrounding regions and irrigation use of urban wastewater over a growing rural footprint – form an emerging global policy challenge, especially as democratizing societies seek institutional means to address both urban growth and water scarcity. A central concern of this paper is to demonstrate that policy regionalism, as a process-based understanding of institutions and decision-making, better explains the causes, forms, and outcomes of hydraulic reach than do more structural approaches. Hermosillo, Mexico presents an unfolding case of rural–urban tension for control over rivers and aquifers as well as the infrastructure for water capture, storage, conveyance, and wastewater release. The analysis employs process documentation of water transfer and wastewater negotiations through interviews, review of primary documents, and field observations. Hermosillo's recourse to negotiated agreements and quasi-market transactions, led by an emerging group of public sector innovators, advances understanding of water policy in Mexico by moving beyond prevailing concerns with the water reform's neoliberal underpinnings to exploration of rapidly changing urban-centered experimentation. We conclude that evolving urban–rural power disparities and water resource landscapes of urban growth will drive continued expansion of hydraulic reach in water-scarce regions globally.

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1. Introduction

Regions around the world experiencing rapid population and economic growth are confronted with environmental sustainability challenges (Meinzen-Dick and Ringler, 2008). Water available to meet a range of human and ecosystem demands is a particularly scarce resource (Molle and Berkoff, 2009). Cities increasingly provision their needs by transferring water from rural areas (Celio et al., 2009). At the same time, water transfers are made complicated by the widespread practice of urban agriculture and wastewater use in irrigated agriculture, in which the physical movement of water into the city limits does not necessarily entail an outright sectoral change of use. In this paper we seek to better understand the causes and forms of urban hydraulic reach, and to improve explanations of future outcomes. We take a *policy regionalism* perspective, here conceived as the institutional and territorial articulation of control over resources, by adding spatial considerations and dynamic institutional process to the concept of “regional institutional frameworks around the delivery of strategic resources and assets” advanced by Ward and Jonas

(2004, p. 2123). We apply this to the negotiated and contested provision of public water and wastewater services. Case material is drawn from Hermosillo and northwest Mexico; however, our analyses are conceived in more generic terms with relevance for other high-growth, water-scarce regions.

Political and institutional contexts are crucial in shaping relations forged among cities and regions, because evolving geographies of competition are produced through the concentration of power and wealth. New regionalism takes as axiomatic economic and creative competition among urban centers and this approach seeks to explain diverse conditions (Ward and Jonas, 2004). As we will demonstrate, a regionalist perspective can account for changing relations between cities and regions. Conversely, examining specific cases of urban power dynamics (McCann, 2003) may yield a depth of contextual understanding that is not readily scalable to other contexts. Consideration of cities' embeddedness in national and global power structures as well as their influence on regional decision-making helps to situate specific cases within broader governance frameworks (Bulkeley, 2005), but still requires an empirical assessment of dynamic relations such as we undertake here.

We are concerned with the urban centeredness of resource provisioning, infrastructure development, and environmental decision-making, particularly the ways in which cities position (and

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re-position) themselves in relation to the state and to the regions in which they exercise power. There is growing evidence that “in-between” cities reshape regional power relations in unexpected ways (Young and Keila, 2009). Lacking global cities’ access to state financial and institutional resources, smaller cities are compelled politically to position themselves regionally to mobilize resources in unique ways. Resource provisioning requires infrastructure development, which can play a crucial, often divisive, role in inter-connecting cities and regions (MacKillop and Boudreau, 2008; McFarlane and Rutherford, 2008).

Service provision and coverage are consistently higher within the city compared to the rural periphery – true for both developing (Castro, 2007) and developed countries (Wescoat et al., 2007). Rural–urban water disparities have considerable health, labor, and financial implications for disempowered, low-income groups and have been seen to compound rural–urban migration (Swyngedouw, 1997). Historically, cities sourced water from the local environment, entailing little by way of infrastructure or competing claims over the resource. However, as water sources become physically scarce through depletion or access becomes limited due to pre-existing, defensible claims, cities resort to water appropriation and transfer from other, more distant uses and users (Howe and Goemans, 2003; Johns, 2003). In many water-scarce regions agriculture represents the pre-existing use cities must compete with (Díaz-Caravantes and Sánchez-Flores, 2011; Celio et al., 2009; Eden et al., 2008; Rosegrant and Ringler, 1998). It should be noted that farmers or irrigation districts are very often engaged in mutual competition.

Because cities’ water transfers and wastewater use have place-based specificity, the negotiation of resource control in a polycentric decision-making arena (Hajer, 2003) requires consideration of the spatial dimensions of hydraulic reach. Source and transfer, upstream and downstream, urban and rural, water and waste all have unique spatialities that overlap with power and institutional arrangements (Sanderson, 2002) to condition the case trajectories observed. This casts in sharp relief the evolution of water management decision-making as driven by the urbanization phenomenon so prevalent not just in Mexico but globally. In the case examined, the roles of federal agencies and municipal authorities evolve in unexpected ways with relation to private interests seeking to drive water and wastewater allocation. This necessitates our method of process documentation (akin to Lemos et al., 2002). Evidence is drawn from interviews of urban managers and their legal counsel, farmers and their representatives, federal and state regulators, and water policy analysts, coupled with review of background documents and final signed agreements.

Structural approaches to the urban water imperative do not adequately account for the dynamism seen in negotiated resource regimes. The innovation of urban authorities and water managers in expanding cities’ hydraulic reach and the resulting redefinition of state–city power relations pose the central theoretical challenge of understanding institutional innovation driving hydraulic reach. By innovation, we refer to new, untested modes of decision-making that challenge status quo jurisdictional authority. Negotiated settlement of competing claims is replacing unilateral water appropriation; this produces new outcomes for winners and requires adaptation by losers. Local, state, federal, and non-state actors are forced to navigate new scales of governance by crossing administrative boundaries and water resource spatial units. In the process, they modify their roles at multiple institutional levels and across territorial and administrative domains.

Policy regionalism thus sheds light on the internal dynamics of the city-region by exposing the relations between the urban center and the territory in which it is situated. This is particularly apparent for the procurement of goods and services on demand in the city, and has important ecological consequences. We advance this new

regionalist understanding by identifying and situating agency and actors, who function as innovators within the city-region. Our interest is to enhance explanatory value of the causes, forms, and outcomes of urban hydraulic reach particularly when compared to other, more structural understandings of the urbanization of water (Swyngedouw, 2004) and differential power dynamics in water provisioning (Bakker, 2003, 2007). Our understanding is based on analysis of process and dynamics, and particularly innovation that may subvert or circumvent established power relations. The case evidence we present suggests that large-scale hydraulic infrastructure approaches, which have high financial and transactions costs, may under certain circumstances give way to negotiated solutions using economic incentives, among other policy tools.

Following this introduction outlining the paper’s conceptual approach, we present and discuss the Hermosillo case while seeking to exemplify generic processes of growth under water scarcity. We complement Hermosillo’s unique physicalities with characterization of institutional dynamics and the roles of federal, state, municipal, ejido (communal land tenure), and private-farmer actors. Thereafter follows a section on the water crisis of the 1990s, which highlights the city’s quest for the next water transfers and the growing wastewater challenge. We review large-scale water transfer initiatives for their relevance to the current context; the first three are failed attempts: El Novillo aqueduct (Section 5.1), the Kino desalination plant (Section 5.2), and the northwest hydraulic plan (Section 5.3); while the fourth, Sonora Sistema Integral (Sonora Sí, Section 5.4), is a proposed program that partially seeks to revive elements of the first three embedded in a sweeping infrastructure plan with Hermosillo at the center. Three water transfer cases—contested by Las Malvinas (Section 6.1), negotiated with Los Bagotes (Section 6.2), and redundant in El Molinito (Section 6.3)—along with emerging negotiations over the city’s wastewater in La Manga and Villa de Seris (Section 7) represent the innovations that we contend are currently shaping water policy in Mexico. We conclude by refining the understanding of policy regionalism as applied to hydraulic reach and institutional dimensions of urban water and wastewater.

2. Historical water geographies of Hermosillo

Hermosillo, with a population of one million, is the capital of the state of Sonora in northwest Mexico (Fig. 1) and has begun appropriating water from an agricultural region where arid conditions make irrigation essential. Sonora’s irrigated area is unsurpassed in Mexico, and the water requirements of agriculture increase from the Río Mayo in southern Sonora to the Colorado River in the north. Only a decade ago, when Mexico’s political regime was more authoritarian, a presidential decree would have sufficed for the city to transfer water from agriculture or release sewage untreated to farmers. Now, with increasing democratization, these processes require negotiation by local governments with powerful private growers and ejido farmers (communal-tenure smallholders who have lost substantially in ongoing water reforms).

The geography of Hermosillo’s hydraulic reach and institutional innovation is generic to many urbanizing regions worldwide facing water scarcity, climate change, and variability. Local policy actors must either conform to or explicitly challenge existing institutional authority structures in moving their initiatives forward. Barkin and Klooster (2006) provide critical commentary on the realignment of authority for urban water management in Mexico. Beyond the municipalization of water service provision in Mexico (Pineda Pablos, 2004; Sánchez Meza, 2008), Hermosillo’s hydraulic reach illustrates the challenges cities worldwide face with water allocation, waste management, and pollution abatement.

Key to understanding the city’s policy regionalism initiatives for water and waste is a brief examination of the city-region’s

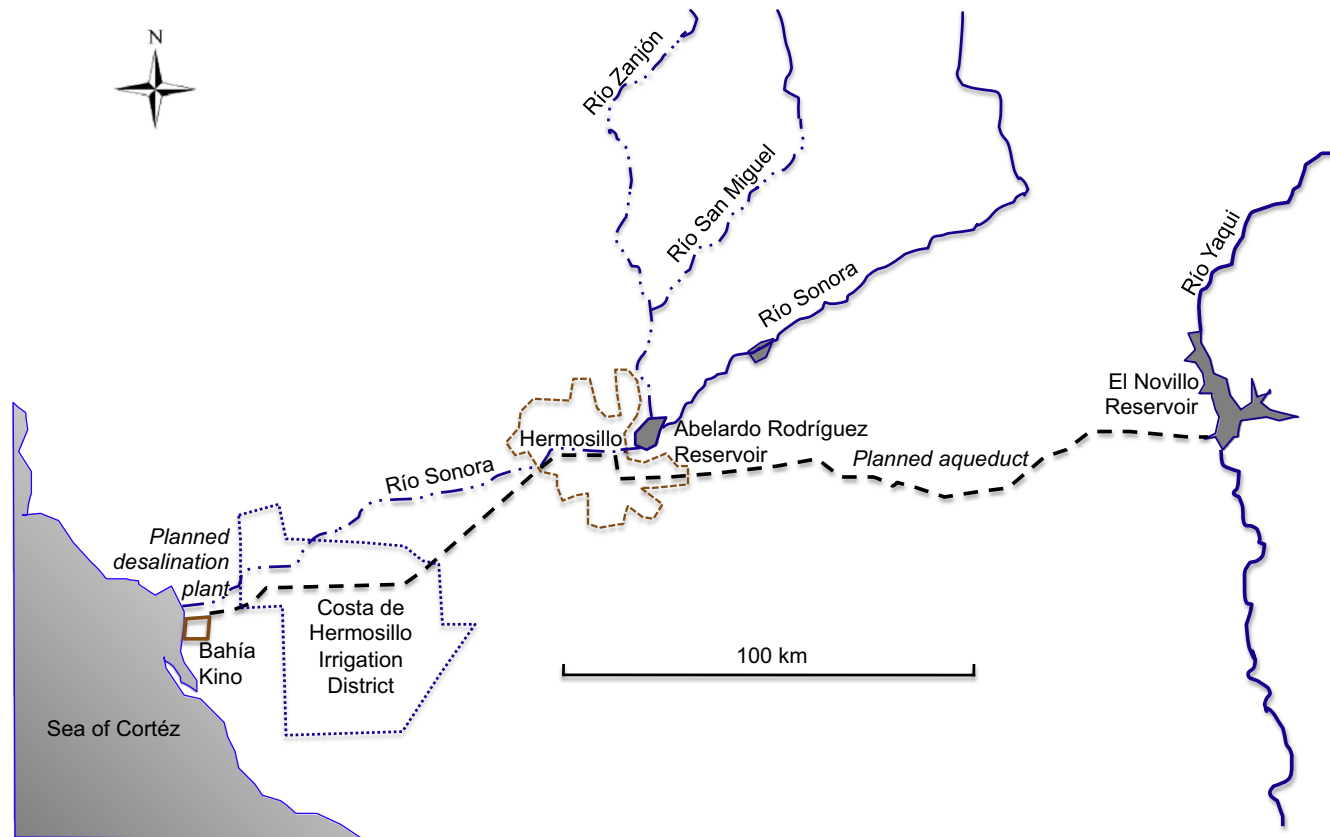


Fig. 3. Hermosillo and planned water augmentation infrastructure.

The combined demand for water for urban and irrigation purposes in the Río Sonora valley, including the Costa de Hermosillo (CH) between the city and the coast (see Fig. 3) grew to significantly exceed available supplies, resulting in intermittent drying-and-filling of the Abelardo Rodríguez reservoir. More insidiously, this has led to aquifer depletion (see Table 1), resulting in rapidly receding water levels and salinization of the coastal fringe of the CH aquifer, despite claims that participatory management of the CH aquifer was a success (CONAGUA, 2003). As a result, by the early-1990s Hermosillo was outgrowing its own place-based water endowments and was compelled to pursue negotiated arrangements to meet water demand.

3. Institutional dynamics

The National Water Commission (Comisión Nacional del Agua, CONAGUA) was created in 1989, the product of a then already well-established, centralized, and technocratic water planning

Table 1
Water balance of Río Sonora aquifers. Source: Moreno Vásquez (2006) based on 2002 CONAGUA data.

Aquifer	Recharge (MCM ^a /year)	Volume concessioned for use ^b (MCM/year)	Estimated actual use (MCM/year)	Deficit (MCM/year) (use/recharge)
CH (Costa de Hermosillo)	250	431	430	-180 (172%)
Río Zanjón	77	90	109	-22 (142%)
Río Sonora	67	115	57	+10 (85%)
Río San Miguel	52	54	57	-5 (110%)

^a Million cubic meters (MCM).

^b See Section 3 on concessions.

process that continues to the present with the National Water Plan (Plan Nacional Hidráulico, various dates). Due to the political and ideological influences of the 1988–1994 presidential administration of Carlos Salinas de Gortari, subsequent aspects of the Mexican water reform process bore a distinct neoliberal imprint (Wilder and Romero Lankao, 2006) in step with modifications to Article 27 of the Mexican Constitution (Wester, 2008). These changes created private usufruct rights but retained national ownership of water. The 1992 promulgation of the Ley de Aguas Nacionales (Law of the Nation's Waters, LAN) established the Public Registry of Water Rights (Registro Público de Derechos de Agua, REPDA), which took a decade to 'regularize' rights as time-bound concession titles renewable at CONAGUA's discretion.

Analysis of the neoliberal character of Mexico's rural development (Walker et al., 2008), environmental law, and natural resource management (Barkin and Klooster, 2006) has characterized the ideological underpinnings of the reform process. We seek to more fully explain organizational interplay and the resulting authority structures that have emerged from the reform process, including the promotion of financial self-sufficiency and private participation in the management of local water systems. In Sonora, water utilities were transferred to the municipalities in the 1990s, but Hermosillo's was not transferred as a municipal corporation until January 2002 due to the local politics of utility control and seemingly insurmountable obstacles to hydraulic reach.

Of particular interest in this paper, then, are the city's contentious claims to water that are exerted with only partial justification to newly created, formal water rights in the REPDA. Based on observed formal and informal attributes of evolving authority structures, our analysis suggests that the locus of decision-making and the process employed to (re-)allocate water and address pollution are increasingly based at the municipal level in Mexico's principal cities. We find that federal authority assumes a regulatory

role supported by financial cost-sharing, relief of water rights' dues in exchange for regulatory compliance, and related fiscal incentives. Sidelined in Mexico's realignment are state government actors; although a state water commission (Comisión Estatal del Agua) does exist in Sonora, its powers are limited in no small measure by insignificant state-level public expenditure. Scott and Banister (2008) have also noted that decentralization along river basin lines is indicative of CONAGUA's efforts to bypass state decision-making. The Sonora Sí infrastructure proposal, described below, is an attempt to situate Hermosillo at the center of a state government-led planning initiative, a further example of a regionalist approach to extending hydraulic reach.

In Hermosillo, water is provided by Agua de Hermosillo (AH), which is legally established as a public corporation and governed by a board (*Junta de Gobierno*). The mayor chairs the junta and directly appoints the AH director. AH's operational budget is largely met from water service fees, which do not provide for infrastructure or investment costs that invariably must be covered by federal, state, and municipal funds. The utility is not financially self-sufficient and remains dependent on subsidies for a significant share of its investment costs. Given that the municipal government changes every 3 years without a re-election option, the AH director tends to rotate in 3-year intervals as well (there were four directors between 2002 and 2010). Such turnover punctuates water supply and wastewater initiatives as described here, requiring continual innovation by new actors.

AH has undergone an institutional learning process characteristic of adaptive water management (Pahl-Wostl, 2007). The city has been forced to position its initiatives in a rapidly evolving regulatory context—one that its own quest for water is shaping in the process. Unilateral positions driven by expedience and financial imperatives are giving way to negotiated arrangements as AH innovators attempt to address its growth and water demand challenges. In so doing, relations with the Hermosillo mayor and Sonora governor proved instrumental in countering well-organized opposition to rural–urban transfers. Thereby, the city exerts normative influence on decision-making for water allocation. Large, capital-intensive plans for water supply augmentation have so far remained an elusive option for the city; nevertheless their discursive value to lend support for more immediate solutions to the water challenge should not be underestimated.

The institutional landscape is clearer and the financial resources more forthcoming for water supply (partly based on drought, climate change, and scarcity discourses; see Morehouse et al., 2000) than for sewage and wastewater. The city has neutralized opposition to the lack of wastewater treatment by pursuing negotiated agreements with an unexpectedly compliant group of sewage farmers. Experience elsewhere in Mexico and other countries suggests that the residual character and social connotation of waste will continue to relegate lower priority to this challenge until federal pollution control and accompanying financial resources are mobilized. The impetus for this is not expected to come from the city or farmers who stand to lose their wastewater entitlement.

Increased municipal and state-level decision-making over water responds not just to the institutionally driven decentralization of water management (Wilder, 2009) but, more critically, to the increasingly complex landscape of actors, challenges, and local needs that distant and disinterested regulators in Mexico City are capable of addressing. Local innovation, we contend, must constructively engage federal authority exerted by the CONAGUA regional office, demonstrated in this case to play a crucial role in regulating the transfers. The lack of local impetus for wastewater management may ultimately return to regionally based federal authority and financial resources. As a result, Mexico's water reforms are today less about the structural underpinnings of the neoliberal model than they are about process, authority, and

alignment with competing interests locally as demonstrated by the case evidence we assemble and present below.

4. Water crisis of the 1990s and next “target” transfers

Since the early 1990s, Hermosillo has actively sought new water sources to support its continued growth; however, numerous attempts to secure new sources have failed. In 1994, President Carlos Salinas inaugurated a new well in La Victoria (Fig. 4) claiming that the city now had water for 30 years, but the well turned out to be contaminated with fluoride and was abandoned. Subsequently, a riverbed infiltration gallery was constructed but never functioned. While seeking new water sources, the city had to survive on a program of water austerity with significantly reduced per capita consumption and efforts to improve water efficiency (Pineda Pablos, 2006).

Attempts to transfer water must take into account the 86% of the Río Sonora basin's water that is used for agriculture (CONAGUA, 2003). Farming here has followed the boom and bust of commodity crops (cotton, table grapes, and pecans) and export markets, interspersed with basic grains (wheat) and subsistence food crops (Lizárraga García, 2004). Market volatility combined with a significant withdrawal of agricultural subsidies and rising input prices have had serious consequences for farmers (Wilder and Romero Lankao, 2006). Government programs to offset farmers' risk targeted mechanization and water-efficient irrigation technology, estimated to cover 50,000 ha in Sonora (Muro Vásquez, 2004). Subsidies have largely been captured by large-scale commercial producers with the result that disadvantaged smallholder farmers are disproportionately subject both to water resource variability and quality degradation (salinity) as well as to market vicissitudes (Eakin, 2006).

Interviews in Estación Pesqueira, on the Río Sonora's Zanjón tributary northeast of Hermosillo, provide farmers' views on groundwater scarcity and their own adaptive response. Large producers rely on intensive irrigation. Illustrative of the adaptive mechanisms employed by large-scale commercial farmers, one grower interviewed pumps 100 liters per second (lps) from 200 m deep using a 400 horsepower electric motor to irrigate 30 hectares (ha) of table grapes plus 30 ha of his neighbor. Their water sharing is informal although electrical power fees and pump maintenance are split between the two. CONAGUA measures monthly water volume using water meters installed at the growers' cost. In earlier fieldwork, water meters were found not to be installed, out of order, or simply not recorded; however, CONAGUA's ability to monitor and enforce concessioned volumes has improved.

The Zanjón and CH areas provide evidence of farms going out of production resulting from groundwater depletion. Regulations allow, with prior CONAGUA authorization, the relocation of a defunct well to another location on the farm or another location within the same aquifer provided the water right concession and pumped volumes are not increased. Despite being capital-intensive, well relocation is common and has concentrated groundwater concessions in the hands of powerful growers under a form of rural–rural transfer with important equity implications. CONAGUA has the regulatory authority to prevent this by not renewing concessions, but pressure from farmers associations has been intense.

“We are the target” for Hermosillo's water expansion, one Zanjón farmer 30 km northeast of the city exclaimed, fretting that there was no remedy to weekend getaway ‘ranchettes’ already cropping up around their farms. However, Hermosillo as a hydraulic and political adversary would, he indicated, require solidarity and organization among neighboring farmers. One neighbor, a large farmer operating 450 ha who is also a leader of the CH farmers' association where the Bagotes groundwater transfer

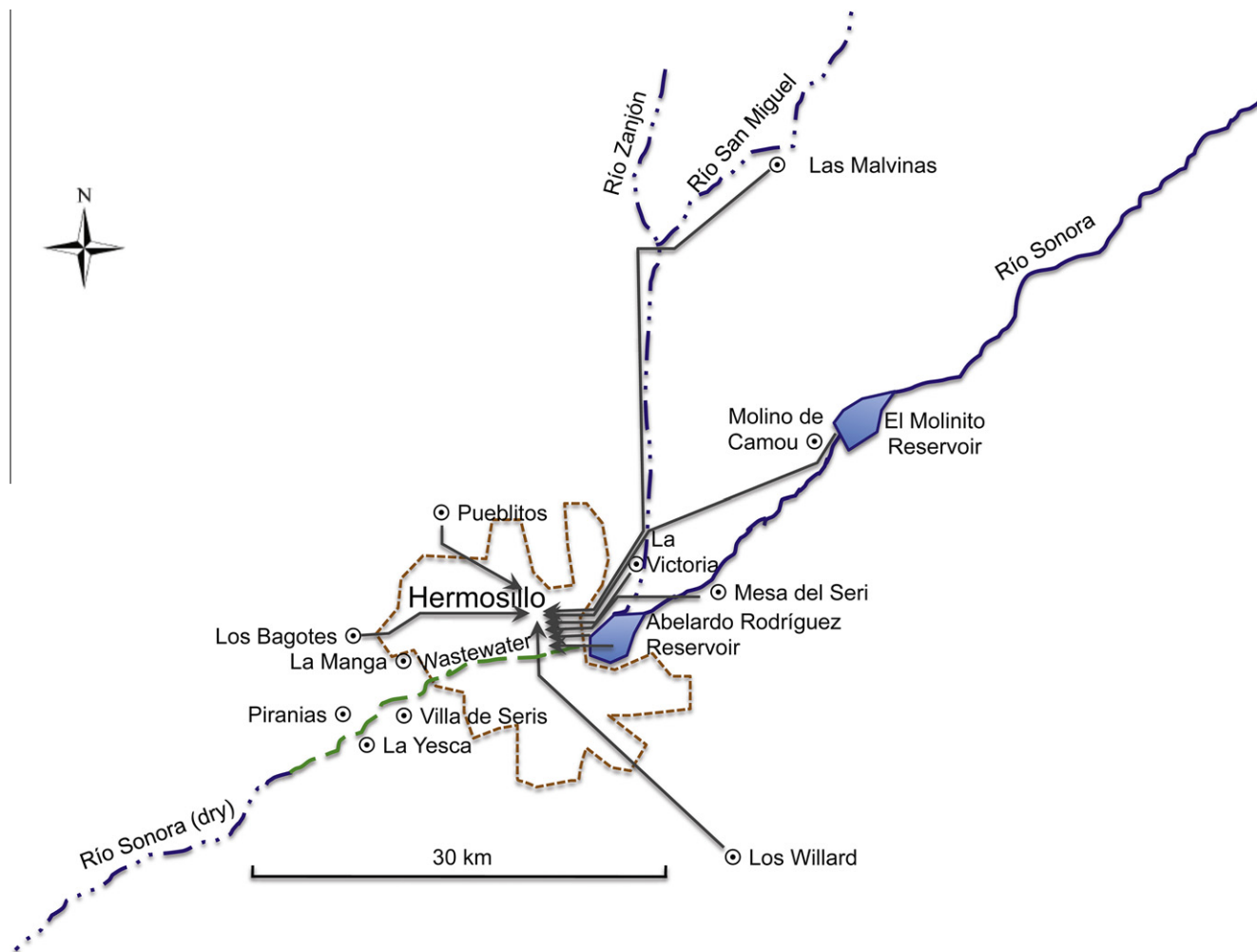


Fig. 4. Hermosillo's hydraulic reach, 2010.

(Section 6.2) took place, has rallied Zanjón private growers who have their own association that works with members to leverage federal labor support and promote marketing. Currently, no negotiations have been initiated between the city and Zanjón farmers who seek compliance with CONAGUA regulations and who, to demonstrate this, have played a role in the installation of water meters that CONAGUA monitors. Nevertheless, the Zanjón aquifer is in serious overdraft with extractions exceeding recharge by 42%. The future of intensive groundwater-based commercial farming in this valley is uncertain, even without the city's growing hydraulic reach.

5. Failed large-scale transfers

It is instructive for our consideration of the process dynamics of Hermosillo's hydraulic reach to assess lessons learned from failed large-scale infrastructure projects. In particular, these shape current strategies by strengthening networks and heightening the role of Hermosillo's policy entrepreneurs, which conceptually are best understood in regionalist terms.

5.1. El Novillo aqueduct

Precedents exist in Mexico for major inter-basin water transfer schemes to supply growing metropolitan areas, e.g., Mexico City,

Tijuana, and Monterrey (Scott et al., 2007). Hermosillo considered within-basin supplies from the Río Sonora to be ultimately limiting for its growth and cast its eye east to the El Novillo reservoir on the Río Yaqui, the largest freshwater body in the state. A straight-line distance of 140 km over the mountains would require a 162-km aqueduct, the city's most ambitious water appropriation yet.

In 1995 the water utility director of the AH-precursor (Comisión de Agua Potable y Alcantarillado del Estado de Sonora de Hermosillo) began promoting the El Novillo transfer idea (Pineda Pablos, 2007). Despite the fact that Sonora shares the Río Yaqui with the state of Chihuahua, crossing this jurisdictional boundary proved less difficult for the city than confronting Sonora's own Yaqui Valley farmers, who vehemently opposed the El Novillo transfer. The city's initial strategy was to publicly appease farmers while simultaneously pursuing closed-door deals to pressure for state government cost-share. Contract solicitations for the aqueduct were issued with the intent to close a deal before the state government changed in 1996. Numerous bids were received; however, state authorities cancelled the process in light of the full implications of the financial crisis and devaluation of the peso. Water supply and its administration in the city continued to face deteriorating short-term prospects such that drastic supply rationing measures were adopted in 1997 and 1998 (El Imparcial, October 2, 1997; December 7, 1997). The El Novillo transfer remains very much in play as the central and most expensive infrastructure element of the proposed Sonora Sí water program (Section 5.4).

5.2. Coastal desalination

Hermosillo abandoned, at least temporarily, the El Novillo scheme but was forced to consider other options to resolve the unmet demand for water. In May 1999, state officials presented desalination as the preferred alternative. The planned reverse osmosis plant would produce 2531 lps (80 MCM per year) from brackish water extracted from 40 wells drilled in the CH aquifer 20 km from the coast. Once desalinated, the water would subsequently be pumped 111 km to the city (El Imparcial, May 13, 1999) at an estimated cost—perceived by decision-makers and the public as extremely high—of Mex\$ 2.1 billion¹ including the plant, aqueduct, and recurring costs. Initial figures set the tariff to supply desal water to consumers at Mex\$ 5.00 per cubic meter, a considerable increase over existing rates.

Contract solicitations for the desal scheme were widely published in the national press and over the Internet on May 12, 2000. That summer, as the national and local electoral campaigns were being waged, a public debate raged with the CH farmers over the impacts the project would have on their irrigation district. Organized producers claimed that pumping brackish water would only further saline water ingress (El Imparcial, July 29, 1999), a process already in an advanced stage as a result of agricultural pumping. Following the July 2000 elections, on September 26, 2000 the state government backed down from plans to pump the brackish-seawater transition zone and to the farmers' satisfaction instead announced it would drill new wells along the coast (El Imparcial, September 27, 2000).

The election results played a determinant role in the institutional dynamics of the desalination scheme. On September 15, 2000 the candidate of the Partido Acción Nacional (PAN) party, which that past July had just taken the Mexican presidency and to which Hermosillo's large growers were also aligned, was sworn in as Hermosillo mayor. He had publicly opposed the project on the basis of its high recurring costs for operations and maintenance (that would have to be borne by the city, even though the federal government would have paid much of the initial costs for construction), and in relatively short order on April 26, 2001 promoted a series of simpler, lower-cost water transfers solutions. The process was too far along, however, to simply be abandoned. On April 3, 2001 contract bids were received and the solicitation closed. Of the eleven bids, Unión Fenosa came in at Mex\$ 8.22 per cubic meter of water delivered to the city. Authorities quickly approved the bid and sent it to the state congress to approve a Mex\$ 300 million line of credit as a contract guarantee for the firm to break ground and initiate the project.

In the face of the desal plant's imminent construction, the mayor formally solicited the state government to transfer authority for water service to the city, based on 1983 reforms to Article 115 of the Mexican Constitution conferring to municipal governments the responsibility for water and sewerage. The mayor would veto the desal plant using municipal prerogative over water resulting from the October 31, 2001 simple majority vote of city council to "municipalize" water service. Thus, indirectly and as a result of collateral municipal action, the desal project was cancelled. With the planned shift from brackish water to seawater as the source and the additional conveyance required, the desal option had escalated in price. With the January 24, 2002 publication of the city council's municipalization accord in the state's official bulletin (Number 7, Section 7), the water utility was formally transferred to the city.

Institutionally, the utility's transfer to municipal administration (that opposed the desal project) and with a finance authorization proposal that faced serious challenge in the state congress, the project's proponents had little scope to maneuver. Furthermore, the December 2000 swearing in of Vicente Fox of the PAN as president of Mexico had two important ramifications for Hermosillo's water quest. The PAN municipal authorities drew strength from their party's historic victory at the national level. More importantly from our perspective on the locus of negotiation and authority, however, CONAGUA's role as the primary federal arbiter and decision-maker on water management—national and local—was sidelined to regulatory observer.

5.3. Northwest Mexico hydraulic plan

The ultimate water transfer is the Plan Hidráulico del Noroeste (PLHINO, Fig. 5), a massive inter-basin river linking scheme on the pattern of the California State Water Project, the Central Arizona Project, Spain's National Water Plan (Saurí and del Moral, 2001), and other major infrastructure projects. If implemented as planned, PLHINO would irrigate over half a million hectares of cropland, adding a tenth of Mexico's total irrigation. Generating a gigawatt of hydropower, its eight new dams and six diversion works would convey water through thousands of kilometers of canals. Crucially, its proponents claim it would assure urban water supplies to cities including Hermosillo. At US\$ 6 billion, PLHINO would cost 0.54% of the total federal budget over 10 years, equivalent to 4.5% of the rural development budget or 9.0% of the combined budgets of the federal agriculture and environment ministries. Without projecting cost over-runs typical for mega-infrastructure, the benefit-cost ratio is a slim 1.13 with an estimated 10.75% internal rate of return (Small, 2007).

Despite the challenges in crossing multiple state boundaries and river basin divides, PLHINO remains in play and appeals to the Sonora public imaginary for the simple reason that augmentation of irrigation, in our view, provides an attractive *quid pro quo* for today's rural-urban water transfers. Which parched farmer would object to water from distant Nayarit and beyond? PLHINO is tacit compensation for El Novillo or CH desalination. We do not expect PLHINO will ultimately be implemented, although some individual components have already been subsumed in Sonora Sí. However, the scheme is emblematic of expanding hydraulic reach and demonstrates how the most ambitious transfers would pit federal initiative acting in concert with state- and local-level interests against opposition in source water basins.

5.4. Sonora Sistema Integral

The Sonora Integrated System is an agglomeration of past, failed-now-resurrected, and future hydraulic reach proposals centered around meeting Hermosillo's growth imperative while placating regional agricultural interests. Dubbed Sonora Sí (Yes Sonora, with the double meaning from the SI acronym), the program is proclaimed as the "sum of ideas, experiences, and efforts of all times" (May 7, 2010 workshop presentation by representative). Predicated on urban water scarcity in the face of agricultural water abundance (domestic and industrial uses reportedly have fifteen times less water than farming and ranching in the state), Sonora Sí would "recover lost water" through efficiency gains without "closing agricultural land; instead, it would increase hectareage".

Following the *quid pro quo* logic of current urban water appropriation in exchange for future irrigation development, agriculture would benefit from Mex\$ 3 billion in infrastructure for inter-state transfer of water from Sinaloa to the south into Sonora's Mayo valley, irrigation improvements in the Yaqui valley where water

¹ For the period analyzed, the exchange rate can be assumed to be a representative US\$ 1 = Mex\$ 10.

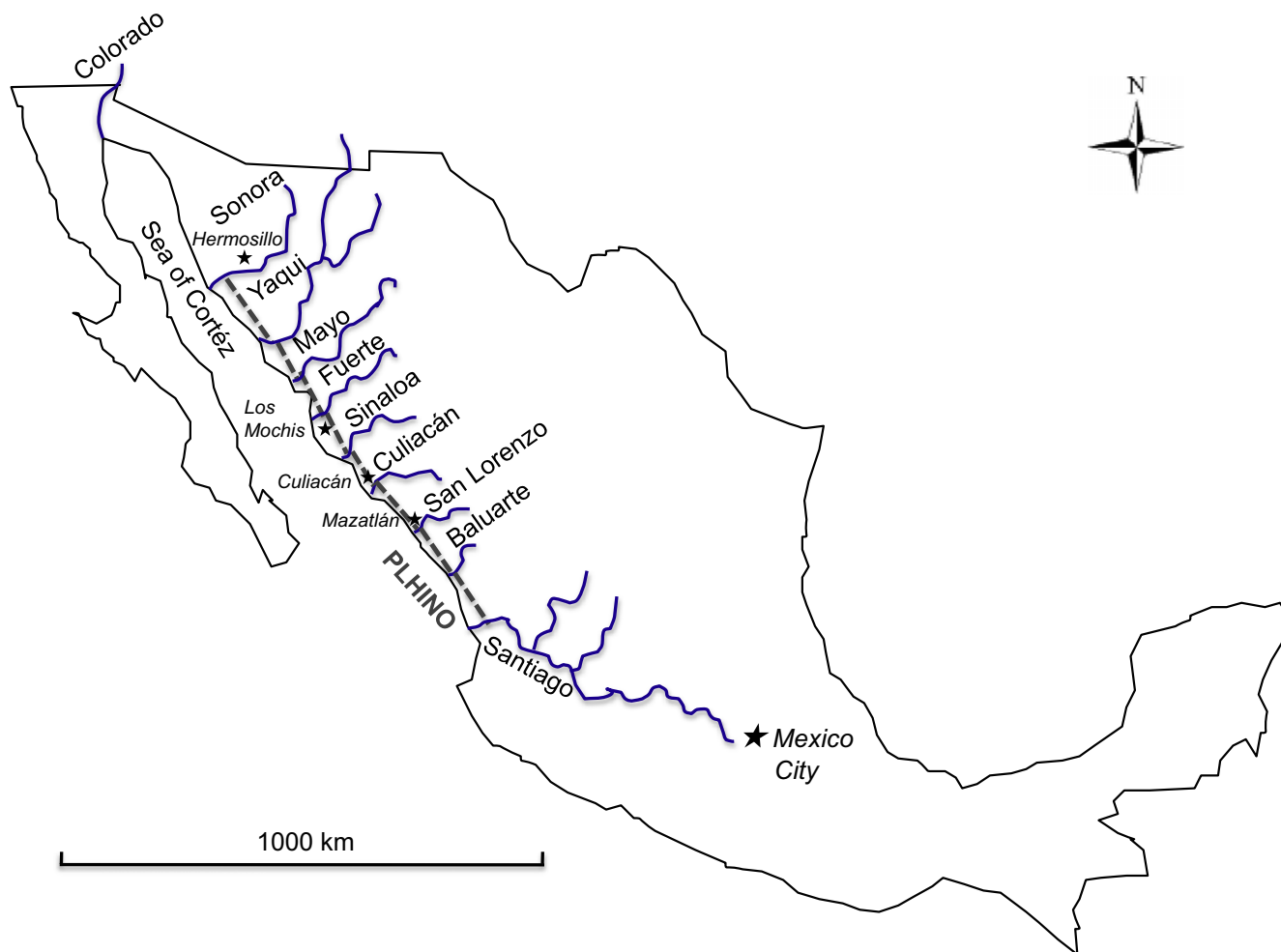


Fig. 5. Northwest hydraulic plan (Plan Hidráulico del Noroeste, PLHINO).

transfers out of agriculture are hotly contested by a well-organized and politically connected irrigation district, and assorted irrigation augmentation plans. The El Novillo transfer and treatment of Hermosillo's wastewater (to be reused predominantly for urban purposes, no longer for peri-urban farming) are budgeted at Mex\$ 4.5 billion under Sonora Sí. Stand-alone desalination at San Carlos (skirting the contentious CH plans described above) combined with major infrastructure upgrades for smaller cities and towns are also designed to appeal to the electorate.

Envisioned to cost Mex\$ 11.8 billion, the program seeks to raise 40% of the required capital through private build-operate-transfer contracts, with an additional 34% to come from federal funds, and the remainder to be met through investment by Sonora state (15%), irrigation districts (3.9%), Hermosillo city (3.8%), and smaller cities. The urban bias of the balance between investment and planned infrastructure is clear.

Resistance by farmers to the perceived loss of water to the city has been backed by political representation of the powerful Yaqui valley irrigation district, supported in some instances by social networks and agricultural-town women's groups. Environmental interests have rallied, unsuccessfully given the primacy accorded to human uses for municipal or agricultural uses of water, in favor of additional instream and estuarine flow, instead of the prevailing public view that this water is "lost" to the sea. In a May 2010 interview, an Hermosillo-based water manager indicated that the current strategy is for the city to negotiate agricultural water rights on the Yaqui River north and upstream of El Novillo reservoir, in

recognition of the difficult prospects of Sonora Sí securing agricultural water transfers through investment in irrigation efficiency improvements downstream in the major irrigated valleys.

6. Water transfer innovations

The city's water challenges could not be resolved by large infrastructure alone, and this option has proven elusive. Instead, a process-based approach was employed, as we outline below. The 1990s growth in Hermosillo's water demand and drought-induced variability in water availability combined to expose AH's institutional vulnerability. In February 2002, the utility returned to municipal government management after decades of administration by the state. From 2002 to 2009, the utility had four changes of director, a rotation that has severely limited the utility's long-term planning horizons and forces a short-term focus on the 3-year period of the municipal government.

Intermittent supply with limited service hours per day that had been initiated in 1996 was met with stiff public opposition. Billboards around town for private, gated communities offered "no water rationing" based on off-grid groundwater sources. Our efforts to interview the current AH chief functionaries led us to engineering managers who detailed millions of liters and kilometers of pipelines needed to address water scarcity (see Fig. 4); for them, further water transfers were inevitable. An interview with an executive of the previous board and his legal counsel, responsible for

the major transfer agreements of the 2003–2006 period, depict an agency frantically seeking to adapt to growth and water scarcity by appropriating and transferring water to the city. The transfer agreement documents and other details gleaned from this particular interview permit us to reconstruct the city's approach to the transfers. We subsequently interviewed farmer leaders who had been involved in the same negotiations and we recount here their positions.

In 2003 the Hermosillo mayor met with the Sonora governor to address the challenge of water for Hermosillo and raised the city's intent to pursue rural–urban transfers (see also Pineda Pablos, 2006). The mayor and AH viewed the aquifers surrounding the city as a “strategic reserve”, particularly those to the north and east where groundwater was concessioned to individuals instead of to farmer associations from whom the appropriation of water would be more difficult. AH also considered drilling new, untitled wells under the drought emergency provisions of article 41 of federal water law (LAN regulations); however, this option was seen as provisional and the wells would subsequently have to be closed, indicating that growth was the foremost imperative for AH and the city. AH opted to pursue the definitive transfer through negotiated purchase of rights instead of temporarily renting or pursuing optional forbearance agreements with farmers (as has been discussed in the US context by Colby et al. (2007)). Water renting on a temporary basis was seen to carry significant transaction costs for both sellers and regulators (CONAGUA), as well as idle infrastructure used to convey the water to the city in years when rental options were not exercised, e.g., because other sources were sufficient to meet demand.

6.1. Contested transfer: Las Malvinas groundwater wells

The first transfer was initiated in 2004 from the Malvinas locale in the Río San Miguel basin 35 km to the northeast of Hermosillo, but this was significantly set back due to organized local protest, CONAGUA opposition, and insolvency of cash-strapped AH. Beginning in 2003, three commercial growers incorporated as a private company in Malvinas offered to sell 250 lps to the city under a homegrown build-own-operate-transfer proposal. AH directors viewed as particularly attractive the Mex\$ 28 million in venture capital raised by growers and their financiers, and as a result they pursued the Malvinas transfer with some vigor. Under the proposed 20-year agreement, AH would purchase a cubic meter of water at Mex\$ 3.22, reduced over the first 10 years to Mex\$ 2.19 to account for pipeline and infrastructure amortization. The agreement specified that water transferred would: (a) be no less than 200 lps and (b) comply with national drinking water standards. During the 20-year lease period, the growers were to retain title to the water. In their view this would obviate the need for change of REPD status from agricultural to public-urban use and, critically, would allow growers to take continued advantage of the subsidized agricultural power tariff in order to pump and supply water to the city. AH entertained at least two other similar offers in the Mex\$ 3.00 per cubic meter range. CONAGUA opposed the proposal and succeeded in having the signed agreement annulled based on the de facto change of use and uncertainty over whether the investors or the city would assume responsibility to pay CONAGUA the volumetric water use fees (waived for agriculture but collected at Mex\$ 0.30 per cubic meter for public-urban use and up to Mex\$ 8.00 for commercial and industrial uses). These fees represent an important source of CONAGUA revenue.

Meanwhile, the Malvinas scheme faced strong local protest, particularly by ejidatarios demanding that water transfers be stayed under all circumstances. A local farmer leader, not himself an ejidatario, was instrumental in organizing ejido interests to take possession of the pipeline right-of-way. AH was forced to acquire

Malvinas water through outright purchase, reinforcing on AH the need to institutionally legitimate the mechanisms it pursued for transfer, i.e., conforming to regulations and based on willing sellers. Additional transfers of agricultural groundwater are planned from the southeast of the city, collectively referred to as Los Willard, and it appears that AH has learned the means to acquire and transfer this water.

6.2. Negotiated transfer: Los Bagotes groundwater wells

AH negotiated water transfer from the Los Bagotes groundwater wells on the western fringe of the city, part of the CH groundwater irrigation district over which the city had begun to sprawl. The CH district had been formally constituted and managed by federal authority prior to the creation of CONAGUA but in 1992 was transferred for management by farmers. Moreno Vásquez (2006) describes the process and implications of decades of intensive groundwater use in the CH; suffice it to say that serious groundwater depletion made this a precarious option for transfer. Two factors, however, explain the selection of Los Bagotes. First, CONAGUA officials interviewed separately indicated it was their agency's role to not simply register, but regulate, transactions of water rights held in the REPD as part of a formally constituted water use rights acquisition program (Programa de Adquisición de Derechos del Uso del Agua, PADUA). CONAGUA perceived an opportunity to reduce total groundwater extraction from the CH aquifer by insisting on (and actually achieving in the final agreement) a one-third volume reduction as a condition for authorizing the transfer, i.e., for every three volumes purchased, two could be transferred to the city, and the remaining one had to be left in the aquifer with the concession formally closed and removed from the REPD. The second more compelling reason was that AH and CH association leaders perceived the opportunity to strike a deal with monetary gains for both sides. As with all transactions of this type, accommodations are made and various interests served.

The AH legal counsel was instructed to seek willing water sellers interested in a price at or below the pseudo-market price of Mex\$ 2.50 per cubic meter stipulated by PADUA. The CH association adopted the dual position of formally opposing any water transfer from agriculture while internally insisting to members that association leaders would bargain collectively. The first well owners to step forward were both ejido and private farmers at the city's geographical margins where farmland was giving way to new urban development. The CH farmers association was able to rein them in on the argument that their first obligation was to sell their rights to other farmers, but rural–rural water transactions had been going for significantly lower rates. The peri-urban zone of interplay raises interesting questions of overlapping jurisdiction. Neither rural nor urban interests held absolute sway, but both entered negotiations as uncharted territory with uncertain outcomes. For its part, CONAGUA was experiencing internal contradictions with regional (Hermosillo-based) CONAGUA officials seeking to wrest authority from Mexico City in the context of Mexico's decentralization drive, also a product of the LAN reforms.

In June 2005, AH directors and the CH association met in the presence of the Hermosillo mayor, the Sonora governor, the CONAGUA regional director, and the federal agriculture department regional director. They agreed in principle to jointly address the city's water scarcity problem via a 20 MCM per year outright transfer subject to federal regulation including CONAGUA's one-third conservation condition. With this approval, the association agreed to consult its members and initiated a collective-bargaining process. Driven by the intensification of drought and the seasonality of summer peak water demand, the asking price rose to Mex\$ 5.60 per cubic meter (implying a Mex\$100 million-plus transaction on the order of El Molinito – see Section 6.3 – for little more than

half the water). Farmers and the association had been feeling the squeeze of rising irrigation costs in the face of uncertainty of farming at large and in the peri-urban fringe specifically, and saw this as a windfall opportunity. With the onset of Sonoran summer at the end of March 2006 and after months of bargaining and behind-the-scenes negotiations, AH acquired use rights for 23 wells totaling 17.4 MCM transferred to the city at an average rate of Mex\$ 3.26 per cubic meter. The single largest and third largest volumes of the 23 rights sold were from La Habana ejido; one of these sold only 45% of its right and received Mex\$ 2.70, the lowest per cubic meter rate of all. Whether this reduction was conceded under duress in order to forge the deal remains a matter of speculation; however it seems apparent that “willing sellers” were subject to market distortions based on unequal bargaining positions.

This collective transfer is referred to as Los Bagotes after the locale where AH pumps groundwater that is then piped into the city. Repositioning of wells and conveyance lines to the city were required at additional cost. CONAGUA supervised the capping of wells representing the one-third required for aquifer conservation. AH currently operates a battery of thirteen wells that pump 60 million liters per day, supplying up to 40% of Hermosillo's water demand during drought when reservoir water is in short supply. The next summer 2006, President Fox made a campaign swing through Hermosillo for the PAN party and inaugurated a package deal of water infrastructure including Los Bagotes. In the intervening period, a conveyance pipe failed or was tampered with by disgruntled farmers. The facility is currently under guard around the clock.

There existed no precedent, regionally or throughout Mexico, for this magnitude of direct financial transaction for water transfer. Mexico City, Monterrey, Guadalajara, Aguascalientes, León, and other metropolises have been transferring water from agriculture based on eminent domain arguments. In these cases, compensation was made in an indirect manner through infrastructure and irrigation efficiency improvements aimed at irrigated agriculture generally in the respective region, not targeted at specific individuals. Hermosillo's case is thus innovative in at least two respects – spatially and institutionally. First, it accessed significant amounts of agricultural groundwater in the peri-urban fringe; and second, the city pursued a directly negotiated transaction approach.

6.3. Redundant transfer: El Molinito

The municipal administration of 2006–2009 oversaw construction of the El Molinito aqueduct, inaugurated in April 2008. Relatively small in comparison to Monterrey's 5 cubic meter per second aqueduct from its adjoining reservoir, El Molinito nonetheless is important in Hermosillo's expanding hydraulic reach; this scheme conveys 1.1 cubic meters per second of water via a 28.3 km-long, 48-in. pipeline from the El Molinito dam to a water treatment plant adjacent to the Abelardo Rodríguez reservoir. The cost of Mex\$ 120 million was co-financed by federal, state, and municipal governments. Technical and water resource uncertainties shadow the project. The aqueduct conveys water from a location upstream that is itself subject to water scarcity, and at one level simply represents water that would otherwise flow subsurface to the city's wells. It does accomplish, however, the appropriation of water from Molino de Camou ejido that is located between the dam and the city (Díaz Caravantes and Camou Healy, 2005). It may save electrical energy that would otherwise be used to pump groundwater, although no economic analysis has been performed. Worse, is it likely that water diverted upstream from El Molinito reduces the amount of recharge to the Mesa del Seri and La Victoria wells that supply the city. It is thus possible that no additional water is supplied to the city, but simply the same water by a different route.

7. Wastewater for ejidos

Even without the major additional water transfers planned from El Novillo or PLHINO, the current water supply and drainage regime in Hermosillo creates a significant wastewater challenge. Despite federal directives for cities to treat wastewater with the possibility of federal cost-share, Hermosillo is Mexico's largest city without wastewater treatment or stabilization. Sewage is released untreated into the Río Sonora. In 1994, a wastewater treatment plant contract had been issued and work begun by Monterrey-based Tecnología e Ingeniería Avanzada (a subsidiary of the large construction firm, Protexa). With the financial crisis of 1995, the government was forced to suspend payments, construction ceased, and the firm sued for damages (a process that continued over the ensuing decade). Little attention was paid either by the firm or the city to the claims by the La Manga ejido to return the land expropriated to construct the plant. The ejido has threatened to repossess the site, which has lain idle for a decade, although abandoned half-built concrete infrastructure prevent the estimated 25 ha from ever being recuperated for agricultural purposes.

As an example of the city's wastewater reach, the system of irrigation canals originally constructed for the Abelardo Rodríguez reservoir now serves as the city's major wastewater drainage network. Less than 10% is used for power generation cooling water. A similar amount is estimated in the city's sanitation strategic plan to be used in landscape irrigation, clearly demonstrating that agriculture remains the primary option for use of wastewater. Initial fieldwork to explore the city's geography and institutions of sewage encountered a void in the scrutiny and interest shown by public agencies and research organizations alike. Sewage has connotations of residuality that are qualitatively distinct from solid waste. It is at once perceived as filthy and a hazard (Scott et al., 2004) and elicits a visceral rejection. The social discourse of “black water” in Mexico is reflected in public sanitation drives exhorting the public to clean up (*cuero* = one's own body, and *cuero de agua* = water body) by locating waste in its place, an out-of-sight/out-of-mind simplistic rendering completely unsuited to wastewater that intermixes with water physically and figuratively in ways that solid waste do not. In the fluid environment and the public imagination, there is no ‘place’ to locate wastewater. Lack of social acceptance will only partially be overcome through public education, even if wastewater is posed as part of the solution to water scarcity and rationing that are equally odious. And in the institutional environment, wastewater falls in the interstices between the water (supply) and sanitation board charged only with collection and disposal, federal water regulators whose primary writ is resource management and regulation, pollution control agencies that monitor quality and environmental impacts but not social implications, public health, and agriculture agencies. This challenge has proved insurmountable for Hermosillo city authorities, resulting in unplanned wastewater use in agriculture despite attempts to claim wastewater for urban landscaping use.

Hermosillo has a vibrant sewage farming corridor that responds to the city's own demand for irrigated produce, chiefly fodder grass for dairy cows. Milk production and sale occur both formally and informally. However, given its residual connotations and the direct water quality implications for agriculture, private farmers with other livelihood options have dropped wastewater farming, leaving only ejido farmers to adapt and innovate with sewage farming. In the Hermosillo sewage corridor, these include La Manga, La Yesca, Piranias, and Villa de Seris. The latter we explore here in greater detail based on planning documents procured from AH.

The Villa de Seris ejido is located along the Río Sonora downstream of Hermosillo and forms part of the Río Sonora irrigation district. The city's expansion has greatly increased demand and

prices for land, while also generating increased amounts of wastewater that the city releases without treatment. Due to the twin facts that water in the Abelardo Rodríguez reservoir is used for urban supply thereby diminishing its availability for irrigation, and that the irrigation canals are used to dispose of a major part of the city's sewage, Villa de Seris's only supply of irrigation is wastewater. The ejido unsuccessfully sought an injunction against AH for disposing sewage in the canals. In November 2005, the state agriculture department put the number of irrigators in the ejido at 195, with a total area of 972 ha. The irrigation district collects irrigation service fees for wastewater, a reversal of the 'polluter-pays' principle. Measurements of wastewater flow are not taken, but estimates based on canal irrigation practices common in this region suggest that Villa de Seris's alfalfa production utilizes half of the city's estimated wastewater flow of 2500 lps. Interviews with farmers indicated little opposition to wastewater irrigation; it is a continuous and reliable supply of irrigation plus it carries all the nutrients and organic matter needed by alfalfa. However, they are constrained in their choice of crops due to regulations and are uncertain about the health and land degradation implications of continuing the practice.

After past failed attempts to centrally treat the city's wastewater, AH initiated plans to construct a smaller plant in Villa de Seris capable of handling 1.6 cubic meters per second, or two-thirds of the current wastewater flow. The plans included purchasing 30 ha of land for the plant and negotiations with the ejido to supply them the treated effluent. In May 2006, AH and ejido leaders met to negotiate and agree on pursuing a land-for-effluent exchange in the institutional context of CONAGUA regulation, with oversight by the Sonora state agricultural department, state water commission, and state drinking and water and sanitation commission. AH's interest in the negotiation was to define existing use and thereby retain control over future growth of wastewater. By law, any water or wastewater discharged to a river (defined as a "federal water body") ceases to pertain to the right holder and requires a discharge permit and fee. CONAGUA had excused AH's accumulated debt for discharge fees on the condition they complete a treatment plant no later than December 2007; this condition remains unmet.

The 2006–2009 municipal administration made unfulfilled initiatives to treat wastewater. In 2007, plans to build a treatment plant were announced with the intent to complete construction before the September 2009 end of the municipal administration. However, inadequate technical expertise and lack of credit have resulted in the project being further postponed. The future is conditioned by Sonora Sí investment plans, as discussed above.

The impacts of Hermosillo's wastewater reach are felt disproportionately by disempowered ejido farmers, who nonetheless count themselves as fortunate to have some water. The informal but farmer-accepted practice of wastewater irrigation has obviated the city's need to adhere to the 'polluter-pays' principle as enforced on other urban polluters. Sewage disposal in the urbanizing Río Sonora corridor is not actively contested by farmers, in part because of the agricultural benefits they derive. However, what may appear to be acquiescence is derived from ejidos' inability to take a seat at the negotiating table (Díaz-Caravantes and Sánchez-Flores, 2011) opened for the water transfer aspect of the city's hydraulic reach. Suboptimal outcomes of this kind result from unequal power and privilege and perpetuate equilibria based on interests of the dominant actor, here AH and its customers who would face the added costs (financial and institutional) of complying with pollution control. However, growing pressure and cost-share from CONAGUA regulators will drive the city to treat wastewater, as evidenced for other metropolises in Mexico (Barkin and Klooster, 2006).

8. Conclusion

The process-based policy regionalism approach to understanding expanding hydraulic reach yields insights not directly derived from consideration of power networks and related structural explanations alone. Chief among these understandings is the significance of negotiated transfers, which require policy entrepreneurs to navigate both institutional and territorial domains. Growing demand for water (and wastewater disposal) under conditions of urbanization bring cities into spatial and institutional juxtaposition with their surrounding rural landscapes. Expanding hydraulic reach to access new water sources and to manage wastewater entails traversing new territory (both land and water). This raises decision-making challenges when hydraulic reach conflicts with pre-existing resource uses. In the process, decision-makers must innovate in the unexplored interstices between rural and urban, and between resource and waste.

From a policy regionalism perspective, Hermosillo's expanding hydraulic reach demonstrates that (a) the locus of institutional innovation is urban-based, (b) state-level interests are either bypassed or co-opted by the hydraulic reach imperative, and (c) federal regulatory authority is increasingly legitimized using fiscal incentives—an option not available at the state level.

Innovators within the Hermosillo water utility experimented—in part, successfully—with negotiated settlements over water transfers, the most ambitious of which were beyond the scope (institutionally and financially) of the city. Navigating jurisdictional authority required by hydraulic reach, e.g., inter-state water claims over El Novillo, proved easier than negotiating or settling contested claims with organized farmers. Hermosillo continues to manage wastewater unilaterally despite both informal wastewater use in irrigation and attempts at negotiated arrangements. Here, federal fiscal incentives (to build wastewater treatment capacity) will play a determining role in outcomes expected in the coming years.

The innovations described demonstrate the realignment of actors and decision-making space that shed light on longer-term policy trajectories in Mexico's water reforms. Federal authority has reconstituted itself in a strengthened regulatory capacity, particularly for environmental sustainability, i.e., aquifer sustainability and pollution control in the Hermosillo case. Negotiated transaction as the choice of means fits within Mexico's medium-term neoliberal project. Given the opening presented to urban-based innovation with the partial retreat of federal authority and continued facilitation at the state level, we consider that future hydraulic reach initiatives will be emboldened. Where local management skills are less well developed, however, CONAGUA may continue to exercise its historical role of the federal authority that circumscribes local action – including negotiations – while defining the scope for innovation.

The ubiquity of urban growth, coupled with water supply and sanitation imperatives (encouraged by the globally-sanctioned Millennium Development Goals), will inevitably entail expanding hydraulic reach in diverse contexts worldwide. This is particularly true of regional cities like Hermosillo that, unlike national capitals and global cities, are limited in their ability to rely solely on power relations to mobilize the investments required for large infrastructure. We have demonstrated that the ability to meet urban water demands and handle waste will increasingly be based on more incremental, innovative approaches involving negotiated settlements.

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References

- Bakker, K., 2003. *An Uncooperative Commodity: Privatizing Water in England and Wales*. Oxford University Press, New York.
- Bakker, K., 2007. Trickle down? Private sector participation and the pro-poor water supply debate in Jakarta, Indonesia. *Geoforum* 38 (2007), 855–868.
- Barkin, D., Klooster, D., 2006. *Water Management Strategies in Urban Mexico: Limitations of the Privatization Debate*. University of South Florida, Tampa.
- Bulkeley, H., 2005. Reconfiguring environmental governance: towards a politics of scales and networks. *Political Geography* 24 (2005), 875–902.
- Castro, J.E., 2007. Poverty and citizenship: sociological perspectives on water services and public-private participation. *Geoforum* 38 (2007), 756–771.
- Celio, M., Scott, C.A., Giordano, M., 2009. Urban-agricultural water appropriation: the Hyderabad, India case. *The Geographical Journal* 175 (3). doi:10.1111/j.1475-4959.2009.00336.x.
- Colby, B.G., Jacobs, K.L., Smith, D.R., 2007. Lessons for semi-arid regions facing growth and competition for water. In: Colby, B.G., Jacobs, K.L. (Eds.), *Arizona Water Policy*. RFF Press, Washington, pp. 219–236.
- CONAGUA (Comisión Nacional del Agua), 2003. *Manejo Sostenible del Agua con Protección de su Calidad en la Costa de Hermosillo y la Cuenca del Río Sonora*. Informe OMM/PROMMA No. 156, Subdirección General Técnica, Gerencia de Aguas Subterráneas. Comisión Nacional del Agua, México, DF.
- Díaz Caravantes, R.E., Camou Healy, E., 2005. El agua en Sonora: tan cerca y tan lejos – estudio de caso del ejido Molino de Camou. *Región y Sociedad XVII* (34), 127–165.
- Díaz-Caravantes, R.E., Sánchez-Flores, E., 2011. Water transfer effects on peri-urban land use/land cover: a case study in a semi-arid region of Mexico. *Applied Geography* 31 (2), 413–425.
- Eakin, H., 2006. *Weathering Risk in Rural Mexico: Climatic, Institutional, and Economic Change*. University of Arizona Press, Tucson.
- Eden, S., Glennon, R., Ker, A., Libecap, G., Megdal, S., Shipman, T., 2008. *Agricultural Water to Municipal Use: The Legal and Institutional Context for Voluntary Transactions in Arizona*. Envirotech Publications Issue #58. <<http://ag.arizona.edu/azwater/publications.php?type=5>>.
- Hajer, M., 2003. Policy without polity? Policy analysis and the institutional void. *Policy Sciences* 36, 175–195.
- Howe, C.W., Goemans, C., 2003. Water transfers and their impacts: lessons from three Colorado water markets. *Journal of the American Water Resources Association* 39 (5), 1055–1065.
- Johns, G., 2003. Where is California taking water transfers? *Journal of Water Resources Planning and Management* 129 (1), 1–3.
- Lemos, M.C., Austin, D., Merideth, R., Varady, R.G., 2002. Public-private partnerships as catalysts for community-based water infrastructure development: the border WaterWorks program in Texas and New Mexico colonias. *Environment and Planning C: Government and Policy* 20 (2), 281–295.
- Lizárraga García, B., 2004. La agricultura de mercado en Pitiquito. In: *El Agua y la Agricultura en la Historia de Sonora*, Simposio XII, Sociedad Sonorense de Historia, Hermosillo, pp. 397–404.
- Mackillop, F., Boudreau, J.A., 2008. Water and power networks and urban fragmentation in Los Angeles: rethinking assumed mechanisms. *Geoforum* 39 (2008), 1833–1842.
- McCann, E.J., 2003. The urban as an object of study in global cities literatures: representational practices and conceptions of place and scale. In: Herod, A., Wright, M. (Eds.), *Geographies of Power: Placing Scale*. Blackwell, Oxford, pp. 61–84.
- McFarlane, C., Rutherford, J., 2008. Political infrastructures: governing and experiencing the fabric of the city. *International Journal of Urban and Regional Research* 32 (2), 363–374.
- Meinzen-Dick, R., Ringler, C., 2008. Water reallocation: drivers, challenges, threats, and solutions for the poor. *Journal of Human Development* 9 (1), 47–64.
- Molle, F., Berkoff, J., 2009. Cities vs. agriculture: a review of intersectoral water reallocation. *Natural Resources Forum* 33 (1), 6–18.
- Morehouse, B.J., Carter, R.C., Sprouse, T.W., 2000. The implications of sustained drought for transboundary water management in Nogales, Arizona and Nogales, Sonora. *Natural Resources Journal* 40, 783–817.
- Moreno Vásquez, J.L., 2006. Por abajo del agua: sobreexplotación y agotamiento del acuífero de la Costa de Hermosillo, 1945–2005. *El Colegio de Sonora, Hermosillo*.
- Muro Vásquez, H., 2004. Alianza para el campo. In: Barkin, D. (Ed.) *La Gestión en la Historia de Sonora*, Simposio XII, Sociedad Sonorense de Historia, Hermosillo, pp. 409–416.
- Pahl-Wostl, C., 2007. Transitions towards adaptive management of water facing climate and global change. *Journal Water Resources Management* 21 (1), 49–62. doi:10.1007/s11269-006-9040-4.
- Pineda Pablos, N., 2004. La municipalización de los sistemas de agua potable y alcantarillado, 1980–1996. In: *El Agua y la Agricultura en la Historia de Sonora*, Simposio XII, Sociedad Sonorense de Historia, Hermosillo, pp. 177–194.
- Pineda Pablos, N., 2006. Dar a beber a Hermosillo. In: *El Agua y la Agricultura en la Historia de Sonora*, Retos, Debates y Bienestar. Universidad de Guadalajara, Guadalajara.
- Pineda Pablos, N., 2007. Construcciones y demoliciones. participación social y deliberación pública en los proyectos del acueducto de El Novillo y de la planta desaladora de Hermosillo, 1994–2001. *Región y Sociedad XIX*, pp. 89–115.
- Rosegrant, M., Ringler, C., 1998. Impact on food security and rural development of transferring water out of agriculture. *Water Policy* 1, 567–586.
- Sánchez Meza, J.J., 2008. El mito de la gestión descentralizada del agua en México. Universidad Nacional Autónoma de México, Instituto de Investigaciones Jurídicas, México, DF.
- Sanderson, I., 2002. Making sense of 'what works': evidence based policy making as instrumental rationality? *Public Policy and Administration* 17 (3), 61–75.
- Saurí, D., del Moral, L., 2001. Recent developments in Spanish water policy. Alternatives and conflicts at the end of the hydraulic age. *Geoforum* 32 (3), 351–362.
- Scott, C.A., Banister, J.M., 2008. The dilemma of water management "regionalization" in Mexico under centralized resource allocation. *International Journal of Water Resources Development* 24 (1), 61–74. doi:10.1080/07900620701723083.
- Scott, C.A., Faruqui, N.I., Rachid-Sally, L. (Eds.), 2004. *Wastewater Use in Irrigated Agriculture: Confronting the Livelihood and Environmental Realities*. CABI Publishing, Wallingford.
- Scott, C.A., Flores-López, F., Gastélum, J.R., 2007. Appropriation of Río San Juan water by Monterrey city, Mexico: implications for agriculture and basin water sharing. *Paddy and Water Environment* 5 (4), 253–262. doi:10.1007/s10333-007-0089-3.
- Small, D., 2007. US and Mexico: cooperate on great water projects. *Executive Intelligence Review – Economics* 7(December), 64–73.
- Swyngedouw, E., 1997. Power, nature and the city. the conquest of water and the political ecology of urbanization in Guayaquil, Ecuador: 1880–1980. *Environment and Planning A* 29 (2), 311–332.
- Swyngedouw, E., 2004. *Social Power and the Urbanization of Water. Flows of Power*. Oxford University Press, New York.
- Walker, M., Roberts, S.M., Jones III, J.P., Fröhling, O., 2008. Neoliberal development through technical assistance: constructing communities of entrepreneurial subjects in Oaxaca, Mexico. *Geoforum* 39 (2008), 527–542.
- Ward, K., Jonas, A.E.G., 2004. Competitive city-regionalism as a politics of space: a critical reinterpretation of the new regionalism. *Environment and Planning A* 36, 2119–2139.
- Wescoat Jr., J.L., Headington, L., Theobald, R., 2007. Water and poverty in the United States. *Geoforum* 38 (2007), 801–814.
- Wester, P., 2008. *Shedding the Waters*. Wageningen University, Wageningen.
- Wilder, M., 2009. Political and economic apertures and the shifting state-citizen relationship: reforming Mexico's national water policy. In: Huitema, D., Meijerink, S. (Eds.), *Water Policy Entrepreneurs: A Research Companion to Water Transitions around the Globe*. Edward Elgar, Cheltenham, UK, pp. 79–96.
- Wilder, M., Romero Lankao, P., 2006. Paradoxes of decentralization: water reform and social implications in Mexico. *World Development* 34 (11), 1977–1995.
- Young, D., Keila, R., 2009. Reconnecting the disconnected: the politics of infrastructure in the in-between city. *Cities*. doi:10.1016/j.cities.2009.10.002.