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The Ostrich Politics of Groundwater Development and Neoliberal Regulation in Mexico

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ABSTRACT: In this article I present the politics that spurred groundwater development in Central and Northern Mexico between 1930 and 1990, and analyse the working/effects of the neoliberal groundwater policies that were implemented in the country since the 1990s. I first present, based on an analysis of the Comarca Lagunera and the state of Guanajuato, the socio-economic, political and institutional dynamics that shaped groundwater development between 1930 and 1990, with a special focus on how with state support large commercial farmers and small *ejidatarios* developed groundwater irrigation. My analysis shows how the actors involved in groundwater development, just like ostriches, stuck their head in the sand, oblivious to aquifer overdraft and its environmental consequences. Then I present how – since the 1990s – neoliberal groundwater regulation policies have worked out on the ground opening the doors to regulatory capture and groundwater accumulation through capital, oblivious to sustained aquifer overdraft, a shrinking peasant *ejido* sector, increased rural outmigration and the health threat of toxic concentration of Fluoride and Arsenic in many groundwater dependent areas. This analysis raises serious doubts about the capacity of – often (inter)nationally lauded – neoliberally inspired groundwater policies to contribute to socio-environmental sustainability and equity.

KEYWORDS: Groundwater, water policy, water markets, water grabbing, agrarian policies, Mexico

INTRODUCTION

The accelerated development of the use of groundwater resources following the advent of tube-well technologies since the mid-1900s has made an important contribution to the socio-economic development of many areas in the world (Shah et al., 2007; Giordano and Villholth, 2007; Giordano, 2009). Groundwater has supported agricultural production and especially that of high value (export) products in Mexico, the Peruvian and Chilean Coast, the US, Mediterranean Europe, the Middle East, India, China and Australia amongst others (OECD, 2015a). Globally, groundwater irrigation is estimated at 23 million hectares accounting for about 20% of global irrigation withdrawals (idem). However, intensive use of groundwater has led to widespread aquifer overdraft with significant negative socio-environmental externalities (Grogan et al., 2017). These call for regulatory responses aimed at redressing these externalities, and transforming groundwater to a long-term source of safe water for the societies that depend on it.

In this global context, Mexico is an interesting country to analyse (agricultural) groundwater development as well as the policy responses put in place to curb aquifer overdraft. First, in many areas of Northern Mexico tube-well technologies were introduced in the early 1900s and their fast uptake spurred the agricultural, industrial and socio-economic development of the country (Wolfe, 2017). What makes this development especially interesting is that the state actively tried to include the

peasant dominated *ejido*[1] sector up until the late 1970s (Perramond, 2008). Second, since the 1990s, Mexican neoliberal water policies have received much attention and were in many aspects seen as exemplary for the rest of the world (Rap, 2006, Wilder and Romero Lankao, 2006). However, little attention has been given to this policy turn in the groundwater sector, with the exception of the development of aquifer management councils (Foster et al., 2004). In this paper I review the processes of groundwater development and neoliberal regulation in Mexico; and through it I give important insights on the governance arrangements in which these unfolded, contributing to a broader understanding of groundwater governance in Mexico and beyond.

The research material for this article was collected through two different methods. The overview of groundwater development in Mexico and the detailed historical account of groundwater development are based on literature review. The case description of the Comarca Lagunera greatly draws on Michael Wolfe's excellent book *Watering the Revolution: An environmental and technological history of agrarian reform in Mexico* (2017). The data on groundwater regulation since the 1990s is based on my long-term research in Guanajuato since 2003. The empirical data was collected through semi-structured interviews and participant observation with producers (large scale and *ejidatarios*), practitioners and policy makers form state agencies, non-governmental organizations and local universities in over one and a half years of fieldwork stretched between 2003 and 2018. Earlier results of this research have been published in Hoogesteger (2004), Wester et al. (2007, 2009a and 2011); Hoogesteger (2017) and Hoogesteger and Wester (2017).

This article is structured as follows. After this introduction, the next section presents my understanding of groundwater politics, which for the sake of analysis are divided into two distinct processes: the politics of groundwater development and the politics of groundwater regulation. I then analyse the politics of groundwater development in the Comarca Lagunera and the state of Guanajuato, with a special focus on how the state included the economic elites and organized smallholders mostly represented by the *ejido*. Subsequently, I present the politics of groundwater regulation since Mexico's neoliberal overhaul in the 1990s. I show how this new wave of regulatory measures liberalized land and water resources, created spaces for user participation and aimed to reduce groundwater use through energy pricing and irrigation modernization, while heavily investing in inter-basin transfers to large cities in over-drafted aquifers. These measures have had little effect on aquifer overdraft, while facilitating groundwater accumulation by capital in a context in which poor rural communities gradually lose their access to groundwater (both in terms of quality and quantity). Finally, the conclusions show that groundwater development and regulation in Mexico has been dually propelled by socio-economically and politically powerful agricultural producers and by state interventions aimed at creating, later sustaining and finally politically containing the *ejido* sector and its social movements. The politics of groundwater regulation that developed since the early 1990s have by and large failed to reduce groundwater overdraft while legally enabling processes of water accumulation by those with capital (large producers, cities and industry) mostly at the expense of *ejidos*' access to groundwater. The analysis shows that politicians, bureaucrats, private companies and powerful users all act alike -just like ostriches-, they tend to bury their heads in the sand and ignore the obvious signs and consequences of sustained intensive groundwater use on the environment, the rural poor and the future generations

[1] Ejido is a communal land tenure system created to provide landless peasants with land after the Mexican Revolution (1910-1920) through the creation of agrarian nuclei. Through the Mexican Land Reform program (1920-1992) half of the country's land was transferred from privately owned large holdings to ejidos. Members of an ejido (*ejidatarios*) technically neither owned nor held title to land but had usufruct rights. Ejidatarios are usually designated individual/family parcels and have access to communal holdings such as forests and pasture lands. In the last three decades most programs and institutions that had supported this sector have been dissolved putting much pressure on ejidatarios who are mostly smallholder farmers (see Perramond, 2008 and Assies, 2008).

(see for instance Foster and Chilton, 2003). This raises important questions about current groundwater governance in Mexico and beyond.

THE POLITICS OF GROUNDWATER DEVELOPMENT AND REGULATION

Groundwater use has come to play an important role in the socio-economic development of many regions of the world and as a result many political and economic interests arise around its use and regulation. That is, the socio-political stakes around groundwater use and governance are high. To better understand these, the starting point of my analysis is that (ground) water governance is a politically contested arena of resource use (Molle et al., 2008; Mollinga, 2008). Therefore, I understand water governance as the processes that shape "how organisation, decisions, order and rule are achieved in heterogeneous and highly differentiated societies" (Bridge and Perreault, 2009: 476). Water governance (re)produces technical, socio-economic, administrative and political structures and dynamics. These structures and dynamics imbue specific actors with power(s) to take and influence decisions that create, recreate and/or transform these very structures through which access to (ground) water is controlled in a specific territory. This leads to specific spatially-bound arrangements of resource development, allocation, use and regulation (Boelens et al., 2016).

There is a wide body of literature that has analysed the politics of river basin closure (Molle et al., 2009; Molle and Wester, 2009; Molle et al., 2010). Molle (2008) points to eight generalized drivers of infrastructure development in river basins and why 'enough is never enough'. These include amongst others the political economy of infrastructure development, the ideology and political appeal of large scale state projects, unclear water rights systems and double accounting, regional politics, high subsidies with taxpayers' money, climatological shock events, agrarian pressure, centralized decision-making and a lack of democratic accountability. Additionally, the pursuit of private financial and political benefits, as well as rewards of such projects, often leads to and fosters rent-seeking behaviour and the curtailment of democratic decision making. Underlying these mechanisms lies the formation of strong coalitions and networks that are able to overcome resistance to such projects (see Rap and Wester, 2013).

The development of groundwater resources, which goes hand in hand with river basin closure, has many similarities with the drivers that lead to surface water infrastructure development; with the biggest difference that it concerns small and dispersed well infrastructure rather than dams. Based on research in Asia, Shah et al. (2003) identified four stages in the development of groundwater resources. These are: (1) groundwater potential is unleashed with the rise of tube-well technology, followed by (2) an agrarian boom, which leads to increasing exploitation of water resources until (3) it reaches unsustainable levels which finally causes (4) damage to the social and or ecological structure (due to a lack of timely intervention) leading to the fall of groundwater dependent societies. These dynamics can be explained by the atomistic character of resource development in which private investments in well drilling and pumping by individuals and small collectives play the dominant role (see Shah et al., 2007; Shah, 2009). The state often plays an important role in these processes, providing loans for well drilling and pump installation; subsidies for fuel and electricity to run the pumps and for agricultural production; and through programs that directly finance well installation for smallholders and rural communities.

In most parts of the world groundwater regulation by the state is weak, incomplete and inconsistent because of its highly political character and its natural characteristics (Shah et al., 2003; Mukherji and Shah, 2005; Closas et al., 2017). Groundwater is invisible and access to it is largely determined by dispersed technologies. It is a 'horizontal' resource, meaning that "farmers [and other users] located above an aquifer can sink wells independently of each other over a significant areal extension" (Kemper, 2007: 156). Groundwater is available on site and needs little conveyance infrastructure, which leads to decentralized management that is hard to regulate. This means that groundwater resources

and regulation often receive relatively less attention and investments from state agencies in comparison to surface water projects (Hoogesteger and Wester, 2015).

The laissez-faire development of groundwater resources has in many cases served to resolve conflicts over surface waters, to appease the challenge posed by social movements and avoid political unrest, to fight poverty, to stimulate and enable economic and demographic growth and to protect the vested interests of local agricultural elites that depend on this resource (Shah, 2009; Al Naber and Molle, 2016; Hoogesteger and Wester, 2017; Wolfe, 2017). These objectives often continue to be pursued long after the point where it is widely known that aquifer levels are decreasing and that groundwater exploitation has reached unsustainable levels (Giordano, 2009). It is at this point that, at least in principle, the politics and discourse of groundwater development evolve into the politics and discourse of regulation; which Shah et al. (2003) characterized as phases 3 and 4 of the rise and demise of groundwater socio-ecologies.

In this article I conceptualize the *politics of groundwater development* as the socio-economic processes that drive the development and exploitation of groundwater resources in a specific region. These can be understood by analysing the actors and socio-technical and environmental drivers of well development in a specific area. The way in which these different aspects intertwine and relate to each other in the governance domain shapes how, where, by whom and under which policies, groundwater is developed and used.

It is well documented that in most countries, despite repeated attempts to regulate groundwater use, no significant reductions in groundwater extractions have been achieved (Shah et al., 2007). Common mechanisms include drilling bans, regulatory control through rights systems with assigned volumes, electricity pricing, and the regulation of drilling companies. Yet, in nearly all areas of intensive groundwater use, water users continue to have nearly unconstrained control over their pumps (Shah, 2009; Hoogesteger and Wester, 2015). Understanding why such regulations rarely have any significant impact on taming groundwater use; and understanding the effects that they *do* have in terms of groundwater distribution lies at the core of *the politics of groundwater regulation*. I use this notion to specifically focus on how policies and regulations aimed at controlling groundwater use (to move toward more sustainable exploitation regimes) are politically negotiated, (ab)used, evaded and twisted by different actors. This has important consequences on how groundwater is accessed, distributed and used.

THE POLITICS OF GROUNDWATER DEVELOPMENT IN MEXICO

In Mexico the Civil Code of 1884 recognized the right of land owners to prospect for and use groundwater, legally opening the doors for individuals to invest in groundwater development. Despite amendments to the law and the promulgation of the Constitution of 1917, which explicitly stated in Article 27 that 'land and water property belong to the Nation' (reaffirmed in the Water Laws of 1929 and 1934), it was difficult for the state to regulate groundwater use as it was not explicitly defined as national property (Aboites, 1998). In 1945 this changed with amendments to paragraph 5 of Article 27 of the Mexican Constitution which stated that:

> Waters of the subsoil [groundwater] may be freely brought to the surface through artificial works and appropriated by the owner of the land, but, when it is in the public interest or if it affects the supply of other users, the country's President [through the Federal Government] may regulate its extraction and utilization, and even establish prohibited areas [*veda*], in accordance with that which applies for other waters of national property (Delgado Moya, 1999: 49).

The legal powers of the Federal Government in relation to groundwater regulation were further increased in 1948, 1956 and 1972. According to the Water Law of 1972, in areas under *veda* it is only allowed to sink new (tube) wells with the prior consent of the national water authority (Peña and

Arreguín, 1999). However, as this section will later show, the implementation of these regulations rarely materialized even though many *vedas* were decreed. Although the state has had the power and responsibility to regulate groundwater since at least 1945, groundwater governance in Mexico has amounted to little more than almost unrestrained – and often state supported – groundwater development designed to increase the productive capacity of the agricultural sector and enhance economic welfare in Central and Northern Mexico. It has formed the basis – especially in Northern Mexico where rain-fed agriculture is constrained by low and erratic rainfall patterns – for the development of highly productive commercial irrigated agriculture and industry. This economic 'boom' became a labour magnet for south-to-north labour migration (agricultural and industrial) (Wolfe, 2013) and led to demographic and socio-economic growth but also to severe problems of aquifer overdraft (Mahlknecht et al., 2008; Scott et al., 2010; Díaz Caravantes et al., 2013).

Figure 1. Overdrafted aquifers in Mexico according to CONAGUA (2018) showing in red, and location of the Comarca Lagunera and the state of Guanajuato, Mexico.

According to official data from the National Water Commission (CONAGUA) in 2016, 33,819 million cubic meters (Mm^3) – that is, 39% of total water conceded by the Mexican state – was groundwater, with most of the concessions issued in Central and Northern Mexico. Groundwater accounts to over two thirds of the water supplied to urban populations, half of that for industrial use and at least one third for agricultural use (idem). The latter sector currently uses over 76% of total extracted groundwater, irrigating around 3 million hectares mostly in the Central Highlands and Northern Mexico (Scott et al., 2010; OECD, 2015b). This area also has most of the country's threatened and overdrafted aquifers (Díaz Caravantes et al., 2013). CONAGUA (2016) recently identified that, of the 653 officially recognized and delimited aquifers,[2] 105 were over-drafted (see figure 1), 18 had problems of marine

[2] In Mexico there is much discussion about the delimitation of aquifer boundaries. Many hydrogeologists argue that the aquifer boundaries established by CONAGUA are administrative rather than hydrogeological boundaries. These differences lead to discussions about research results, what a sustainable aquifer yield is and what policies are needed to achieve this.

intrusion, and 32 had salinisation problems. Additionally, many aquifers, especially in Northern Mexico, are reported to have concentrations of Arsenic and Fluor that exceed (sometimes greatly) national and international public health norms for drinking water (Armienta and Segovia, 2008; Ortega-Guerrero, 2009; Hernández-Antonio et al., 2015; Mora et al., 2017; Knappett et al., 2018). To understand the processes that led to such widespread aquifer overdraft in the following sections I outline in detail the groundwater development trajectory of the Comarca Lagunera and the state of Guanajuato.

La Comarca Lagunera[3]

La Comarca Lagunera (also referred to as 'La Laguna') is an arid (200 mm rain/year) flat region that occupies large portions of the states of Durango (north-eastern) and Coahuila (south-western). This area forms the lower basin of the Nazas and Aguanaval rivers that used to feed and sustain the intermountain valley lakes of Mayrán, Tlahualilo, Laguna Seca and Laguna del Álamo. The combination of fertile sedimentary soils, abundant sun, good temperatures and water from the rivers led to its utilization for irrigation since pre-colonial times. Just as in the rest of Mexico, most of the irrigable lands were divided during Spanish colonial times into large *haciendas* (landholdings).

In the 1800s the production of cotton in this region started to become important and expanded, especially after the torrential flows of the Nazas River were diverted. Flooding of the fields took place from September to November, after which wheat or cotton were planted. Cotton requires extra irrigation in March or April after the dry winter months, for which many producers used groundwater from shallow dug wells (Wolfe, 2017: p.34-40). The expansion of the irrigation networks, 'modern' technologies, new industries and the arrival of the railway in the 1880s enabled investors in the agricultural sector to profit from economies of scale, creating an agricultural 'cotton boom' that attracted wage labourers to the region. By 1910, 100,000 hectares of cotton were cultivated by twenty four landowners with estates of between 1000 and 15,000 ha (*idem:* 42-43).

Between 1910 and 1917 the Mexican Revolution stirred the region. Following the revolution, debates about the construction of a dam on the Nazas intensified, with large landowners, fearing that their water rights would be curtailed, mostly opposing the plans and arguing that the dam would put an end to the yearly supply of fertile sediments to the fields and imperil groundwater sustainability. The proponents of the dam were mostly local smallholders, workers and technicians who hoped to access land through agrarian reforms, water from the river and foreseeing a new and important source of labour during dam construction (idem: 67-78).

Yet, while land and water redistribution (the revolutionary promise of agrarian reforms) stayed at bay, a silent groundwater revolution started to unfold in the region. From the early 1920s onwards, engineers, politicians, smallholders and landlords all welcomed the arrival of motorized pumps for groundwater use. In 1924 alone 84 wells were installed, by 1928 there were 160, a number that increased tenfold in the following decade. Only the wealthy *haciendas* could install these motorized pumps, due to the high cost of doing so. This allowed them to increase their irrigated area and production and stabilise agricultural employment, which reduced social tensions and calls for land and water redistribution. By 1932, La Laguna had 365 motorized tube-wells and the first impacts of their use on the aquifer system were detected. Geologists from the National Irrigation Commission (CNI) reported that in 1932 and 1934 (both years of low river flows) aquifer levels had dropped by between 7 and 15 meters, depending on the area, triggering the first calls for state regulation. Despite these calls, new pump installation companies settled in the region as politicians advocated the use of pumps to augment water supplies and sustain economic growth. By 1935 the supply of energy to run the pumps

[3] This section is based mostly on the excellent book *Watering the Revolution: An environmental and technological history of agrarian reform in Mexico* by Mikael Wolfe (2017). See www.water-alternatives.org/index.php/boh/item/7-wr

had become an issue of concern as the pumps had become an essential element in the region's agriculture (idem 78-83).

With the election of Lazaro Cárdenas as president of Mexico in 1934, agrarian reforms came onto the national agenda. In La Comarca Lagunera, peasant and labour organizations increased their political mobilization to unprecedented levels and landlords prepared for massive expropriation. In the last two weeks of August 1936, more than twenty thousand unionized workers organized a strike on more than 150 haciendas (out of 226) in La Laguna, demanding higher minimum wages, housing, medical attention, drinking water and land to fulfil the promises of the 1934 Agrarian Code. This strike ignited Cardenas' land (re)distribution reforms that, by 1938, had distributed 146,000 ha of irrigable land (out of 218,000) among 38,000 heads of family organized into 312 *ejidos*. These were to receive credit, seed, fertilizer and machinery from the Ejido Bank. However, access to water remained an unresolved issue for most *ejidos* (idem: 95-110).

In the midst of the land distribution turmoil, in November 1936, the Mixed Waters Commission (responsible for managing the waters in the region) urged Cárdenas to halt and regulate drilling and groundwater abstractions. A month later a Presidential Decree ordered CNI to draw up proposals to legally regulate groundwater use. At that time an estimated 900-1000 wells were installed and 550 more were planned. Pumping in the upstream regions had become so intense that 95% of the urban wells in Lerdo went dry for several months every year. Yet groundwater development remained unbridled. By 1938 the thousand private properties that remained in the hands of the local bourgeoisie still irrigated 70,000 ha and controlled about 500 of the best wells, while the 38,000 *ejidatarios* had about 600 pumps (many of which had problems) for their 140,000 ha of irrigated land, leading to them having water access problems (idem: 112-116).

In the meantime the Palmito Dam on the Nazas river was in full construction and there was hope that after its completion many existing water conflicts would be solved (idem 117-127). However, in 1941 with up to a third of the irrigation in the region relying on groundwater extracted by an estimated 2500 wells, engineers cautioned that the new dam and the termination of the traditional irrigation practices would severely affect groundwater recharge and the existing hydrological cycles. In 1949 the first well sinking prohibition zones (*veda*) were established in selected areas of the Laguna. As groundwater tables kept dropping new *vedas* followed in 1951 and 1952 (idem: 170-190).

In the late 1940s agrarian policy in Mexico shifted from land reform to concentrate on commercial production aimed at providing basic grains for domestic consumption, fodder for growing chicken, pork and dairy industries and the production of high value export crops to boost the economy (Hewitt de Alcántara, 1978). As part of this policy the government aimed to expand groundwater irrigation by 40,000 ha/year in the country as a means to increase agricultural production and make inhospitable arid lands 'verdant and prosperous', triggering groundwater development in other areas including the Coast of Sonora and Baja California, Chihuahua, Zacatecas, Aguascalientes, San Luis Potosí and Guanajuato.

By the early 1960s the number of wells in the Laguna had increased to around 3000 and saw the peak of functioning wells in the region with about 2700 (idem: 192-196). Between 1963-1972, the surface irrigation system was 'rehabilitated' by lining the main canals with concrete and creating compact zones of irrigated *ejido* land. In 1968 the new Francisco Zarco/Las Tórtolas Dam on the Nazas River complemented the regulation of the river. A geo-hydrological report from 1978 pointed out that the 'modernization' of the irrigation system had reduced the recharge of the aquifers to 200 Mm^3 from an estimated 400-500 Mm^3 under 'traditional' irrigation in the 1930s. In the years that followed the aquifers continued to drop and water quality problems increased. The number of functioning wells decreased to around 2350 by 1974, when dangerous concentrations of Arsenic in groundwater were reported for the first time (idem: 209-216). Since 2007 the waters of the Aguanaval River have also been dammed and controlled, further reducing aquifer recharge in the Laguna Aquifers (Cháirez Araiza

2005; Cháirez Araiza and Palerm, 2005). Agricultural production in the region has switched from cotton to fodder crops for dairy since the late 1970s, partly driven by the consolidation of the dairy agro-company LALA group, dominated by the local elite that has important stakes in the irrigation system and controls most of the groundwater wells (Ahlers, 2005). In parallel, an important poultry and beef sector depending on imported feed has developed (Romero Navarrete et al., 2012).

According to García Salazar et al. (2006) between 2001-2003, all surface water and 86% of total groundwater in the Laguna region was used for irrigation, 4% for livestock, 7% for urban and 3% for industrial demands. In 2008, in the seven aquifers of the Laguna region almost 825 Mm^3 were conceded by CONAGUA in water titles, recharge was calculated at 904 Mm^3 and total extractions at 1,338 Mm^3 leading to a total deficit (overdraft) of around 400-450 Mm^3/year (CNA, 2008 cited in Romero Navarrete et al., 2012). As a result, aquifer levels continue to decrease by an average of 1.5 to 3.5 meters/year with pumping depths now ranging between 120-200 m and new wells being drilled to depths of between 300 and 400 m. At the same time the pumps of many *ejidos* have run dry and groundwater quality problems have increased (Romero Navarrete et al., 2012).

The state of Guanajuato

The Bajío region, which stretches through the south of the state of Guanajuato, had been the 'granary' of the country since colonial times. Its fertile soils, irrigation from the river, favourable climate and proximity to some of Mexico's most important mining centres made it a strategic area for the production of basic grains well into the mid-1900s. Groundwater development started almost four decades after it did in La Laguna, after the revolutionary agrarian reforms and land distribution policies had largely been implemented (Wester, 2008). While the state efforts of CNI in Guanajuato mainly focused on the development and expansion of surface water irrigation (Wester, 2009); groundwater development was mainly spurred by private landowners in the Bajio and later in the Laguna Seca region in northern Guanajuato (Hoogesteger, 2017). The number of wells is reported to have increased from 100 in 1940 to over 2000 in 1960 (Hoogesteger and Wester, 2017). By 1982 around 10,000 wells had been dug and at present there are more than 17,300 officially registered wells (idem), although officials interviewed estimate this number to be much higher, more than 20,000. This increase occurred despite the first two *vedas* being established as early as 1948 and the whole state being under *veda* by 1983 (Wester et al., 2011).

The government has played an important role in groundwater development for both urban and irrigation use. After 1960, the transformations in the Bajío of Guanajuato quickly switched from traditional grains to feed grains; mainly sorghum and alfalfa for the dairy industry. Alfalfa, which was grown exclusively with groundwater because of its high water demand, expanded from 10,000 ha in 1960 to over 45,000 ha by 1982 (Wester, 2008) and over 52,000 ha by 2011 (INEGI 2015). Much of this produce is presently exported to the dairy sector in La Laguna region.

In the 1970s the Secretary of Hydraulic Resources (the successor of CNI) started promoting groundwater use to spur agricultural production, even though most aquifers had been under *veda* since 1964. Thousands of wells were sunk in the following decade. Most of these were sunk by middle-sized and large farmers who received subsidized state credits. With the lurking threat of new agrarian protests mostly led by the *ejido* sector, the National Plan of Small Irrigation Works was launched in 1969. This program provided hydraulic infrastructure to *ejidos* to forestall rural discontent. The program covered the costs of drilling, installing the necessary equipment and running electricity lines to the pumps. It added 14,000 hectares of groundwater irrigated land between 1970-1976 in Guanajuato (Solis, 1976).

After 1982 agricultural policies promoted the production of export crops and the rise of frozen and fresh export vegetable production further expanded groundwater irrigation. According to Steffen Riedeman and Echánove Huacuja (2003), the first companies active in the fresh vegetables sector in

Guanajuato in the 1960s were international food companies processing fresh vegetables for the Mexican market (see also Bivings and Runsten, 1992). In the 1980s and 1990s several new Mexican-owned companies opened (Steffen Riedeman and Echánove Huacuja, 2003). The same authors identified that by 2000 there were 18 agro-export enterprises; a number that has continued to increase since then, partly stimulated by the reduction of import-export tariffs between Mexico and the United States and Canada.

As a result, Guanajuato has become one of Mexico's most important production and export area for fresh, canned and frozen fruits and vegetables (Financiera Rural, 2008). Broccoli production alone was estimated to cover 38,000 ha in 2014 (SDAyR, 2016). In 2017, the Coordinator for Export Stimulation of Guanajuato (COFOCE) registered that between January and October the agro-export amounted to a net value of over US$1,144 million, from companies in 27 municipalities (Horticultivos, 2018). The bulk of the production of both agro-export vegetables and fodder crops for the dairy industry is in the hands of large producers/landowners, most of which operate as family businesses. These family businesses control between a hundred and sometimes up to more than a few thousand hectares of land (either through contract farming their own lands or rented land).

According to the CEAG (2016) with almost 16,500 tube wells in use groundwater extraction in Guanajuato reached almost 4000 Mm^3/y, while recharge is around, or just below, 3000 Mm^3/y with average aquifer levels falling 2 m and extremes of above 4 m. At present agriculture consumes 76% of the total extracted volume of water, with 21% used for public water supply and 3% for industry (idem). The drying up of wells has forced those that can afford it (cities, industry and large landowners) to deepen their wells to between 250-500 m and sometimes up to 700 m. Meanwhile the *ejidos* and rural communities are losing access to water in the race to the bottom of the aquifers. At the same time surface water irrigation districts in Guanajuato are being encouraged to switch to drip irrigation and to transfer water to the growing cities, thereby reducing irrigation return flows to aquifers.

Just as in the Laguna, the politics of groundwater development in Guanajuato have mostly been dominated by powerful commercial producers with political and economic clout who have economically thrived on groundwater irrigated agriculture. At the same time the state provided *ejidos* and rural populations with wells for irrigation and domestic water supply in an effort to control social unrest and supported the *ejido* sector in order to fight rural poverty, gain legitimacy and win votes (despite existing *veda* decrees).

THE POLITICS OF NEOLIBERAL GROUNDWATER REGULATION

Following the so-called 'Washington Consensus', and under pressure from the World Bank, the political economy of Mexico has been dramatically transformed since the 1980s. The country has opened up its economy and privatized state-owned companies, resources and banks (Reis, 2017a). This has brought a strong wave of decentralization of state institutions, affecting both water management institutions (Rap, 2006; Wilder and Romero Lankao, 2006) and agrarian support programs (Assies, 2008; Perramond, 2008). The *ejido* sector has lost most of the privileges and special support that sustained it since its creation after the Mexican Revolution. During 1992-1993 a series of constitutional reforms paved the way for the privatization of land (Assies, 2008) and water resources (Ahlers, 2010; Reis, 2017b) as part of the government's efforts to 'neo-liberalize' the Mexican countryside (Appendini, 2014; Kay, 2015) and the governance of natural resources (Heynen et al., 2007; Wilshusen, 2010). The combined pressure of agrarian liberalization and groundwater decline pushed many *ejidatarios* out of production. Some stopped using their pumps because of the unaffordable costs while others could not invest in deepening and/or repositioning their wells. The result was increased flows of migrants to both Mexico's cities and the United States, the precarization and feminisation of rural labour, and the intensification of work (Marañón Pimentel, 2010a; Kay, 2015). In the following section I analyse how

the new groundwater governance mechanisms accelerated this process while failing to reduce aquifer overdraft.

Administrative regulation and privatized groundwater resources

The 1992 National Water Law and its regulations (1994) introduced private concession titles (rights), granted through the National Water Authority and registered in the administrative system of the Public Registry of Water Rights (REPDA) (Reis, 2014) in order to grant 'legal security' to water users. Concession titles are granted for a specific annual volume over the period of the concession (between five and fifty years, usually ten) and must be renewed (LAN, 1992). These allow the owners to extract,[4] use and cede part, or the whole, of their conceded volume to other users of the same aquifer (Scott et al., 2010). Users are legally required to have a working water meter on the (tube) well and to report the volumes that they extract four times per year to CONAGUA. Non-compliance can be penalized with high fines.[5] However, in the agricultural sector, which operates most pumps in the country, compliance with regulations is low and most users either don't have a meter or, if they do, it is damaged or altered; making it well-nigh impossible to measure the extracted volumes (Hoogesteger and Wester, 2017). As a consequence, the volumes of water extracted by this sector far exceed the concessions granted, as illustrated in the main aquifer of the Laguna region where groundwater concessions amount to 642.5 Mm^3 but the extracted volumes total 930.9 Mm^3 (CONAGUA, 2015). In the Jaral de Berrios aquifer, Guanajuato, organized users of the Technical Groundwater Council (COTAS) calculated that collective extractions in the aquifer were double the conceded volumes.[6] As one former CONAGUA director remarked: "there are no flow meters that are 'Mexican proof'".

The 1992 Water Law introduced a volumetric water fee, payable by public, urban and industrial users with the aim of 'rationalizing' water use through economic incentives as well as generating state revenue. The cost per cubic meter varies according to the sector and agricultural water users (aquaculture, irrigation and livestock) are exempt from paying this fee (LAN, 1992). This exemption has historical roots and has been zealously guarded by the powerful agricultural lobby. Fees from water rights have become an increasingly important source of revenue for CONAGUA (Scott and Shah, 2004). Therefore, CONAGUA tightly controls the (much smaller) industrial water use sector and, to a lesser extent, the public and urban water supply sectors (Reis, 2014). Yet agricultural water usage remains relatively unaffected, as recounted by a water user in the Spring of 2016:

> I have not seen the authorities limit anybody's water use. If you have a pumping permit, a concession title, you have the right to pump a specific amount of cubic meters per year. I have not seen the National Water Authority or any other authority sanctioning anyone who exceeds their limit. I do know that the National Water Authority is after illegal wells and I also know that the efforts to control these are insufficient and that there are illegal wells everywhere.

While the regulatory system coupled to REPDA is, at least on paper, a powerful administrative instrument for regulating groundwater use, its implementation is incomplete as CONAGUA lacks the institutional capacity and personnel. For instance in Guanajuato, CONAGUA has the capacity to carry out 280-320 annual inspections (for more than 20,000 existing wells).[7] As a result there is little control over water use in the agricultural sector. My fieldwork suggests that bribing inspectors is a widespread practice. On occasion, abductions of inspectors by angry farmers have occurred, further delegitimizing

[4] One concession title can include one or several wells.

[5] The procedures, rights and obligations attached to the concession title are established in detail in Articles 20 to 29 of the National Water Law and its amendments (LAN, 1992).

[6] Interview with COTAS personnel, March 2016.

[7] Interview with CONAGUA personnel February, 2018.

state control. Throughout the years the preferred, and most accommodating, option for inspectors, bureaucrats, politicians and users alike was to 'legalize' irregular wells. This has been done through regular Presidential amnesties allowing 'illegal' pumps to become legally registered (Scott and Shah, 2004). This has contributed to the over-concession of water rights – the legally conceded volume exceeding the estimated aquifer recharge – in many Mexican aquifers (Scott et al., 2010). The stop to the process of regularization of wells under REPDA in 1999 made it impossible (in principle[8]) to acquire new groundwater rights directly from the state in regions under *veda* (Reis, 2017b), meaning that water (re)allocations were *de facto* left to private water markets (see Easter et al., 1999).

Groundwater markets

Since 2001 (based on the 1992 Water Law) CONAGUA has implemented a system of water rights transmissions in order to enable water (re)allocations amongst users and to newcomers (CONAGUA, 2012a, p. 8). The system of transferring concession titles is regulated by Articles 33 to 37 of the National Water Law, which allows concession titles to be permanently transferred to other users either in totality (the entire conceded volume) or partially (only a part of the conceded volume) (Art. 30). Water transfers can only take place within the confines of the boundaries of aquifers and river basins as defined and delimited by CONAGUA. The transferred water volumes are sectorally interchangeable (i.e. they can involve a change from agriculture to industry or potable, etc) and can be extracted from a well at another location within the aquifer, with the prior consent of CONAGUA.

As water remains the property of the nation and may as such not be 'sold', water rights transmissions are, in legal terms, free of charge and only involve an administrative fee to CONAGUA. However, in the context of a growing demand for groundwater concession titles by real estate developers, industry and commercial agriculture, a lively water rights market (technically a 'black market') has emerged in many aquifers subject to *veda* (Reis, 2014; Hoogesteger and Wester, 2017). The 2013 suspension of free access to groundwater in those parts of the country where groundwater had not been regulated (DOF, 2013) has further spurred water markets in the rest of the country.

Water concession titles have become important for the industrial and housing sectors and, to a lesser degree, for agricultural water users (Reis, 2014). Industry and housing need them because of the tight regulation imposed by CONAGUA and in order to get construction and operation permits from municipalities and other state entities. In agriculture the concession titles are an important way to access state subsidies for electricity and irrigation modernization programs (Hoogesteger and Wester, 2017) and, increasingly, to comply with the regulatory demands of organic certification companies and the corporate social responsibility practices of agro-export companies.[9]

With wells drying up because of aquifer overdraft in many areas, many *ejidatarios* are eager to sell part or whole of their water concession.[10] This is leading to the increased accumulation of groundwater in the hands of private landowners and agri-businesses. Ahlers (2010) shows that in the 1990s increasing pumping depths, together with high electricity costs and the lack of credit available to economically stressed farmers forced many *ejidatarios* in the Comarca Lagunera to give up irrigated agriculture: "by 1998 20,000 water users had sold or leased their water rights, of which 12,000 licences were bought by 4 private holdings" (idem: 221). Large landowners and agri-businesses continue to secure their access to groundwater through sinking deeper wells and buying up new (ground) water

[8] However there have been several decrees that offered regularization to those who extract water based on 'expired' titles such as in 2004, 2008, and 2014 (DOF, 2014).

[9] Interviews with producers in Guanajuato and personnel of organic certification companies, Spring 2016.

[10] Interviews with a technician of COTAS Rio Laja, *ejidatarios* and producers in northern Guanajuto, Spring 2016. See also Ahlers, 2005.

titles (idem). My research shows a similar process is underway in northern Guanajuato, where large producers have started to buy former *ejido* lands and water concessions to expand their production.

A COTAS technician in Guanajuato explained that tradable water rights have opened mechanisms for the 'legal' installation of new tube-wells, which was confirmed by users I spoke to.[11] Users 'buying' water rights can get permission from CONAGUA to install a new tube-well to access and use the acquired volume of groundwater. However, when only part of a water concession is 'sold' by the original user, the latter maintains the right to operate his/her well to extract the remaining volume. In a situation where regulatory control is low, both 'legal' pumps can operate without restraint, potentially leading to higher aquifer extractions even though on paper the conceded volumes remain unaltered.

In the current Mexican context of high water prices and closed regularization, accessing 'new' groundwater titles in the water market has become a privilege only open to those with capital (large producers, industry and housing). As such, these water markets have served as a political tool to facilitate the 'smooth' exit of *ejidatarios* and smallholders whose wells run dry or whose production systems collapse while at the same time those with capital accumulate groundwater through 'legal' appropriation. In this way productive abundance and growth in the agro-industrial and industrial sectors are sustained and the water demands of growing cities are accommodated. Yet this occurs at the cost of rural communities which increasingly find themselves landless and/or waterless (as pumps run dry and/or water permits are sold) and have to find new livelihood strategies in local labour markets and/or through migration (Díaz-Caravantes and Wilder, 2014).

Energy pricing

With the aim of levelling the playing field between Mexican, US and Canadian agricultural producers the Chamber of Deputies passed the Rural Energy Law in December 2002 to regulate market mechanisms and incentives for (among other things) electricity use in agriculture. This resulted in a special subsidized tariff (Scott and Shah, 2004) which was only available to users with a valid concession title from CONAGUA who could prove that they were using their water concession for agriculture. Though the exact amounts have fluctuated over the years, the costs are substantially lower than for domestic and industrial use (Scott and Shah, 2004). A rise in electricity tariffs in the early 1990s saw a substantial reduction in agricultural electricity consumption, from 72 GWh in 1989 to 57 GWh in 1992 (Palacios, 1999). Further proposed increases in the electricity tariff have been repeatedly blocked by Congress (Wester, 2008). The Federal Electricity Commission (CFE) has great problems billing energy users in the agricultural sector.

With the reduction of electricity subsidies in 2000 a large group of farmers united in the national *Comité Pro-Mejoramiento del Agro Nacional* (CPAN) and its local constituent organizations.[12] Electricity users, particularly *ejidatarios* and middle size private landowners belonging to this movement, refuse to pay their agricultural energy consumption. The debts of some of these users are now, on paper, higher than the net value of their production system. CFE inspectors regularly disconnect tube-wells from the power grid, but these are easily re-connected and CFE has little power against the organized users who readily mobilize in order to defend the interests of their fellows[13] (Hoogesteger and Wester, 2017).

The lack of transparency and inconsistent billing by CFE has further strengthened CPAN. Some users have reported being billed enormous energy costs even though their pumps were not functioning or

[11] Interviews done in the Autumn of 2014.

[12] Interviews with water users belonging to CPAN, Autumn 2016 and Spring 2018 and leaders of the movement in Guanajuato, Summer 2003.

[13] Idem

were broken down. Others have reported staggering billing differences between users with similar pumps and water use.

The federal government has extended amnesties writing off up to 90% of the debts that users had accumulated with CFE. One such amnesty was passed in 2003-2004 and ten years later a new one was negotiated.[14] CPAN lawyers are exploring a legal loophole which establishes that after a certain number of years, a debt can no longer be claimed.[15] Regional CFE offices have started to make compromises with users. During fieldwork I met with two *ejidos* who had agreed a 'reasonable' monthly flat rate with CFE. In the meantime the largest producers, who have all their administration in order through their networks, lawyers and political power, have access to subsidized energy and 'preferential' treatment by CFE.[16] Interviews with vegetable farmers in northern Guanajuato (2016) who paid their regular electricity bills to CFE showed that they estimate their electricity consumption to be around 10-15% of their total agricultural input costs. In this context of erratic energy pricing by CFE and, given the large differences in the economic productivity of irrigated agriculture, unorganized *ejidatarios* get the short end of the stick leading some to stop their wells and altering or abandoning their production systems (see Rivara, 2018).

Groundwater user associations

In 1995, as part of its decentralization and user participation policies (Wilder and Romero Lankao, 2006), Mexico spearheaded the creation of Technical Groundwater Councils (COTAS) as a means to support the regulation of groundwater use by the state (Wester et al., 2009b). This strongly influenced the World Bank's recommendations on groundwater governance (Foster et al., 2004). COTAS are established as civil society associations, whose elected directive board and members are water users. COTAS have been legally recognized as auxiliary organs of CONAGUA since 2004, under the amendments set out in Art. 13 BIS 1 of the National Water Law of 1992 (LAN, 1992). Based on these provisions, CONAGUA has delegated programs to the COTAS and recognizes them as intermediaries between water users and CONAGUA. However, these associations have, up until now, not acquired any legal powers in the regulation of groundwater except that of supporting and giving advice to the authorities.[17]

In many of the country's aquifers COTAS have not yet been established. Where they have, it has been mostly at the initiative of state agencies that have financially and logistically supported their creation. Most existing COTAS operate with few staff (usually a manager, one or two technicians and administrative support) and serve a few hundred to a few thousand users dispersed over large aquifers, limiting their capacity for outreach. Most COTAS in the country depend financially on direct and indirect funding from CONAGUA and/or the state water commissions. This gives these institutions a powerful voice in what the COTAS do and how they operate (Wester et al., 2011). It also bears evidence that most COTAS have not become self-financing institutions carried by organized users.

In many aquifers COTAS have become instruments that lobby for the interests of its members and its Boards of Directors, which are mainly made up of agricultural water users. For instance, in Guanajuato some COTAS have lobbied for increasing conceded water volumes for existing users. Others have actively engaged as brokers in local groundwater markets, while supporting users in administering and regularizing their water use concessions. Many have become intermediaries that help users access subsidies to modernize their irrigation systems (Hoogesteger and Wester, 2017). Others have taken on

[14] Interview with a technician from COTAS Rio Laja, Spring 2016.

[15] Idem

[16] Idem

[17] Interviews with technicians from COTAS, Spring 2018.

more research oriented activities. In the Northern Coastal aquifers some COTAS are promoting the desalinization of groundwater for irrigation at the farm level; and the COTAS of the Maneadero Aquifer has lobbied for, and negotiated, re-using wastewater from the city of Ensenada to irrigate export flowers grown by *ejidatarios.*[18]

Throughout the years most of the Boards of Directors have been dominated by large producers. This partly explains why outreach to *ejidatarios* in many COTAS is minimal. Pells (2014) reports that, in the Guadalupe Valley in Baja California, the local COTAS was dominated by the local wine growing elite that benefited from the institution and its contacts with CONAGUA. By and large COTAS have not evolved into broad user-based institutions that advance collective agreements to stabilize aquifer overdraft (although their actions are always framed in these terms) (Marañón Pimentel, 2010b). Their financial dependence on state institutions, low user engagement, limited capacity, weak legal position and capture by elites have forestalled their potential to become effective regulatory mechanisms (see also Wester et al., 2011).

Surface water transfers and the modernization of irrigation

To guarantee urban water supplies in many water-stressed aquifers – often the agricultural sector is the main groundwater user – the preferred option of CONAGUA and the state governments has been to construct facilities for inter-basin water transfers instead of groundwater regulation. This has been the case in the cities of Querétaro (Acueducto I and II), San Luis Potosí (Realito Dam), León (Zapotillo Dam) and Monterrey (Water transfer Monterrey VI) (PNI, 2014).

In many irrigation districts, CONAGUA has heavily invested in the 'modernization' and pressurization of surface water irrigation systems (to enable the use of sprinklers and drip lines) in order to increase "irrigation efficiencies and raise production" (CONAGUA, 2012b). The modernization of the Purísima irrigation system in Guanajuato aims to reduce agricultural water use and 'liberate surface water' for the public water supply of the city of Irapuato. The same idea is being considered in Celaya with La Begonia irrigation system and in Aguascalientes with the Pabellón de Arteaga irrigation system.[19] Aquifer recharge from irrigation return flows of these irrigation systems are (knowingly) being reduced through these programs. However, little research and few publications have quantified the changing water balances and the effects on groundwater.

Following the same rationale, the federal and many state governments, mostly through their agricultural departments, have invested in the 'modernization' of groundwater irrigation systems to "increase irrigation efficiency and crop production while reducing groundwater use" (see Hoogesteger, 2017). In Guanajuato, subsidies to modernize groundwater irrigation systems have been in place since 1996 and have supported the installation of a total of 30,000 ha of drip irrigation, 18,000 ha of sprinkler systems and 146,000 ha of piped conduction systems (SDAyR, 2014; 2015) with a potential 'saved' volume of 440 Mm^3/year (idem). However, these savings are not reflected in the aquifer balances of the State Water Commission (CEAG; 2016). Interviews with water users who have 'modernized' their irrigation systems indicate that irrigation modernization (especially drip) has increased irrigation efficiency and enabled the intensification of crop production and higher yields per hectare, especially for vegetables, but has not led to lower pumping volumes (see also Hoogesteger, 2017).

[18] Uniradio Informa - March 2, 2017, www.uniradioinforma.com/noticias/ensenada/468438/dirigira-cotas-de-maneadero-pimentel-cardenas.html

[19] Fieldwork notes January-February 2018.

CONCLUSIONS: THE OSTRICH POLITICS OF PRODUCTIVE ABUNDANCE

The development of groundwater resources in Northern and Central Mexico has followed the first three stages of the development of groundwater socio-ecologies identified by Shah et al. (2003). The cases of the Comarca Lagunera and the state of Guanajuato, although situated in different decades, show similar dynamics. The most important driver of agricultural groundwater development was the capitalized private sector of medium and large commercial producers linked to national and international agro-industrial chains (cotton, vegetables and dairy). Beside these capitalized producers, as part of the state's agrarian/land reform and rural social support programs, a smaller (in terms of number of pumps, extracted volumes and irrigated hectares) state-subsidized *ejido*-based groundwater irrigated sector developed. This sector was created and sustained by specific *ejido* programs until the late 1970s (see Perramond, 2008). During the 1980s support for this sector was gradually reduced. The development of more intensive groundwater use in agriculture (and other sectors) was allowed, supported and enabled by the state, despite early warnings about aquifer overdraft, legal amendments and *vedas*. The preferred option was to stimulate the productive development of the private and *ejido* sectors, in order to encourage rural development and capital intensive/highly productive agriculture. This resulted in the (re)creation of an agro-industrial elite, and the political containment of the peasant/*ejido* movement whilst successive governments and others responsible for water management stuck their heads in the sand over problems of aquifer overdraft and environmental degradation.

In the 1990s, under great international acclaim, the program of 'inclusive' groundwater development designed to protect the *ejido* sector (although it always had limited access to groundwater) was abandoned in favour of a more neoliberal regime of groundwater regulation. This has created an agricultural playing field dominated by capital (Appendini, 2014). The privatization of *ejido* lands and water has 'legally' opened the doors for capital intensive agriculture to enter new frontiers through capital driven (land and) water re-allocations, made possible by an incomplete administrative and regulatory system. The development of participatory institutions for groundwater management created toothless water user associations (COTAS) prone to elite capture. They have little capacity and/or motivation to work on the problem of reducing extractions to curb aquifer overdraft. These 'softer' administrative and institutional policies have been supported by attempts to introduce solutions that rely on technical hardware.

In line with broader agrarian policies, the irrigation modernization programs have led to increased agricultural productivity (especially through drip irrigation) but have not reduced agricultural groundwater use. At the same time the solutions designed to meet the ever growing water demand from conurbations and industry are based on technical solutions (hydraulic works for inter-basin transfers and the modernization of existing irrigation systems) rather than trying to tackle the problems of ineffective groundwater administration and regulation. This allows powerful pumpers to retain unfettered access to the water that sustains the productive abundance of the agro-industrial sector and the race to the bottom of the aquifers. In this race, those with capital have the winning hand as they can sink and use ever-deeper pumps and have the capacity to buy and accumulate new land and water from those who are losing the race, mostly *ejidatarios* and smallholders who, at best, can sell their water concessions to capital or, at worse, lose their access to water without compensation (Díaz-Caravantes and Wilder, 2014). The neoliberal groundwater regulation mechanisms are broadly aligned with (corporate) capital interests (see also Reis, 2017b), sustaining and enlarging national agro-industrial elites and attracting corporate capital and (trans)national agro-industries which are transforming the economic and social relations of production (see Kay, 2015). Neoliberal water and agrarian policies are thus encouraging, defending and entrenching capital and the economic elites in the groundwater governance arena whilst disregarding long-term aquifer sustainability, human health threats and widespread rural poverty.

These developments – which have changed resource control mechanisms and resource distribution patterns without tackling aquifer overdraft – raise serious doubts about the capacity of – often (inter)nationally lauded – neoliberally inspired groundwater policies to contribute to socio-environmental sustainability and equity. It also calls for an exploration of the politics of groundwater development and regulation as a means to better understand how, why, by whom and for whom policies work out on-the-ground in different contexts.

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