**Drinking each other’s milkshakes:** **Rural to urban groundwater reallocation between regulation and targeted expropriation in Jordan**

**Abstract**

In response to rising urban water demand some regions have reallocated water from irrigation to more valuable uses. However, groundwater over-exploitation is increasing cost and decreasing the quality of aquifers, and states have struggled to control overuse. This study asks whether growing urban requirements enable the reallocation of groundwater from irrigation to higher value-added uses in domestic and industrial consumption. The paper is based on a series of interviews with policy makers and academics in Jordan combined with remote sensing analysis of one reallocation dyad. The results find that regulatory measures such as tariffs and well licensing lacking broad interest-group coalitions had limited impact on agricultural water use. Instead, a targeted expropriation of water users, combined with supply expansion, did succeed in reallocating over 50 MCM of groundwater. The results suggest that urban water needs do increase political support, but that support is insufficient to overcome the typically steep practical and political challenges to reducing overuse. We discuss the strategy of targeting only aquifers with low political and enforcement costs, for future reallocators.

**Keywords**

Groundwater management; Jordan; water reallocation; water policy; water management; urbanization

**Introduction**

As the world’s urban population and economy grows, demand for water in urban regions is increasing (World Bank, 2018). By 2050 urban water demand has been project to increase by 80% (Forke, Schneider and Mcdonald, 2018) and the number of urban dwellers living in regions with seasonal water shortages grows from 500 million in 2000 to 1.9 billion (McDonald et al. 2011). Padkowski and Gorelick (2010) find that 36% of sampled surface-water-dependent cities are in closed basins where surface water is already overallocated amongst environmental, irrigation and urban demand. Growing needs have created new conflicts between rural and urban water users competing for scarce resources (Garrick et al. 2019; Celio et al. 2010; Punjabi and Johnson, 2018; Hooper 2015).

Once local supplies are exhausted, water resources of rural regions can be attractive solutions for cities (Garrick, 2019). Water reallocation is the transfer of water between users who are committed formally or informally to a certain amount of water. As the prefix implies, reallocation changes a previously existing distribution of access. “Reallocation occurs when the existing allocation is physically impossible, economically inefficient, or socially unacceptable” (Marston and Cai 2016: 1); or at least when decision makers see the existing allocation as impossible, inefficient or unacceptable.

Urban water suppliers often reallocate agriculture water it is usually the largest consumer of water provides less gross value added and employment per cubic meter compared to domestic or industrial consumption (Schiffler et al. 1994; Rawlins, 2019; Acharyya, 2019). Proponents of reallocation in groundwater specifically argue agricultural use deprives both future generations and higher-value-added applications, creating an implicit state subsidy (Tetreault and McCulligh, 2018; Schiffler et al. 1994).

Rural-urban reallocation have been criticized for overstating economic gains, as water is rarely a limiting factor for non-agricultural production (Molle and Berkoff, 2009) and for threatening the livelihoods of the global poor (Meinzen and Wringler, 2008). According to Meinzen and Wringler (2008) reallocation risks reducing farmer incomes while increasing food prices. If production does increase, the affected farmers may not access those benefits. Some case studies advocate compensation for farmers (Komakech et al., 2012; Birkenholtz, 2016). Extensive academic work around reallocation therefore focuses on equity and compensation mechanisms (Molden, 2007; Celio et al. 2009; Hoogesteger and Wester, 2015; Hommes and Boelens, 2017; Dai et al. 2017).

These studies have focused on contexts in which urban users have greater influence over state decisions (Komakech and Bont, 2018; Punjabi and Johnson, 2018). However, urban bias is not universal (Pierskalla, 2015). In some states farmers may be more infleuncial than high-value-added water users. In the Texas legislature and judiciary, landowners have prevented any regulation of groundwater pumping (Kaiser and Phillips, 1998). Australia’s water markets by recognizing even lapsed rights to the benefit of farmers(Wheeler et al. 2014). In Yemen tribal elites successfully oppose any groundwater regulations (Zeitoun et al. 2012). In Morocco, state-sponsored megaprojects served interests of politically connected, wealthier farmers (Houdret, 2012).

*Groundwater Reallocation*

Most work on water reallocation focuses on surface water, partly because groundwater reallocation faces steeper practical and political challenges. Firstly, when surface water is reallocated users often turn to groundwater. As urban users appropriate surface water, farmers often switch to groundwater, mitigating short term social consequences (Molle and Berkoff 2009).

Secondly, reducing groundwater abstraction presents high political and practical challenges (Molle and Closas, 2017; Blanco-Gutierrez et al., 2011). Community governance has succeeded in some contexts but is dependent on specific community characteristics (Ibid.). States have incentives to over-assign groundwater, often by allowing private wells for agricultural use to proliferate and exploit aquifers at unsustainable rates (Molle, Lopez-Gunn and Steenbergen, 2018; Hoogesteger and Wester, 2015). Once abstraction is significantly greater than the recharge rate, reducing abstraction is often beyond the realistic means of the state. While states can pass regulations to limit wells and groundwater abstractions, groundwater regulation is rarely effective. Extensive resources are required to regulate and monitor large numbers of dispersed wells, in addition to and political barriers (Hussein, 2018). The political incentives almost always support greater consumption, rather than demand management (Zeitoun, 2012; Molle and Closas, 2017). Increasing consumption creates short term growth and employment, and decreased consumption threaten economic recession, job loss, displeased interest groups and potential instability (Shah et al, 2019). Steenbergen et al. have argued that focusing on “political will”, as interest of ministers and heads of state, obscures important factors in groundwater governance such as corruption, clientelism, informal governance mechanisms, regional autonomy, and soft power (2015).

Despite the challenges, some states have attempted to reallocate groundwater. Competition between agriculture and higher-value-added users can lead to overabstraction, which may cause declining water levels, salinization, and pollution. In some urban suppliers have attempted to prevent farmers from accessing groundwater. In Chennai India, the Metro Water Board attempted to ban groundwater extraction in hundreds of peri-urban villages to protect its supply (Punjabi and Johnson 2018). In Mexico, Darcy and Tetreault argue that the failure of the state to enforce laws privileging domestic consumption over industrial and agricultural water rights has led to higher concentrations of arsenic in domestic water (2010). Perth, Windhoek, Singapore and San Diego, seeking sources without competition, use managed aquifer recharge to replenish aquifers under their regions control (World Bank, 2018).

This article examines reallocation of groundwater in Jordan from 1997 to the present. It asks whether growing urban needs allow more successful reallocation of groundwater by changing the political context. Failures of public water supply, as occurred in Amman in the summers of 1998 and 2007, could change the incentives on states to strengthen usually lax groundwater regulations. The threat of future urban shortages may overcome political barriers preventing a more forceful state-centred response to aquifer decline.

*Article structure*

The article first summarises urban supply shortages Jordan faced in the 1990s and 2000s. Second, it reviews a debate between donors, creditors and elements of the Government of Jordan (GOJ) who supporterd reallocation from agriculture, but disagreed about how it should be achieved. The World Bank proposed volumetric tariffs on all water users, including small farms, to close unproductive farms. Jordanian negotiators instead proposed an expensive megaproject to connect Amman to distant, underutilized aquifers (a hybrid solution combining some reallocation with supply expansion). Thirdly, the article describes the implementation of the two strategies. Strong political resistance from northern farmers and high enforcement costs led regulators to focus on preventing new farm construction, rather than reducing agricultural extraction. The fourth section describes the closure of southern farms for the pipeline which faced lower political costs partly due to their isolation and reliance on migrant labour.

Fifth, our discussion compares the successes of the two policies. It then describes the political effects of urban water requirements, and to what extent they shaped groundwater policies. We then comment on why expensive megaprojects remain popular in Jordan, despite the low margins of groundwater farming near Amman. Finally, the article discusses overcoming the political and technical challenges to groundwater reallocation by targeted expropriation.

**Methodology**

Interviews for this research were conducted in June and July 2018 and in April through August 2019. We interviewed 18 people in total including Ministry of Water and Irrigation (MWI) staff, academics, NGO staff, and development agency staff. The sample represents a broad cross-section of organizational types related to groundwater reallocation, with the exception that farmers are significantly underrepresented in the sample.

Many respondents did not agree to be quoted or recorded, so notes were taken by hand and later transcribed. The interview style was semi structured, with questions focusing on groundwater demand management policies, reallocation, the responses of farmers, and the selection of donor aquifers. We complemented the interviews with a comprehensive review of secondary literature, covering academic writing, media publications, reports from development agencies, and strategy papers of the MWI directly.

During the interviews, we were interested in to what extent rural-to-urban reallocative agenda motivated projects, but were concerned about prejudicing responses. Many responders were aware that western scholars tend to support rural-to-urban reallocation and may overstate the rural-to-urban agenda of the policy. To resolve this problem all respondents were first asked about the agenda of the program in the abstract, to receive unbiased comment. Only afterward were they asked about rural-to-urban transfers. Several policymakers stated that they did not have a rural-to-urban agenda. For example, a donor agency staffer working on the Highland Water Forum stated they intended to reallocated between wealthier and poorer farmers through crop selection, and that rural-urban conflict derailed the intended discussion.

In this text, urban water user or city water use refer to municipal and industrial (M&I) users. In Jordan almost all domestic consumption is supplied by the MWI and WAJ. Private companies distribute within cities the GoJ has insisted on centralizing the allocation decisions in the MWI (interview with MWI policymaker, interview 9, 1). Industrial and commercial users receive special permits from the MWI which are not subject to prior-use restrictions, but do have tariffs (Interview with MWI staff, interview 11). Use of domestic water for farming is forbidden, but sometimes occurs (interview with academic). Agricultural water supplied by the state is mostly restricted to the Jordan Valley, plays a small role in this article (surface water in dams is almost always reserved for municipal and industrial use). In the highlands and the Disi area, farmers are supplied by their own wells or natural springs unless otherwise noted (surface water and rainfed agriculture exists in parts of Ajloun, Amman and Yarmouk).

**Evidence**

*Reallocation Drivers and Supply and Demand*

Already in the late 1990s, growing urban demand for water presented a challenge to both the MWI, and Jordan’s overseas benefactors. In report released in 2001, the World Bank argued that the requirements of Jordan’s municipal and industrial sectors would increase by 87% by 2016 (from 342 MCM needed per year in 1998 to 639 MCM). These projections were cited frequently in policy-advocacy papers co-authored by leaders at the MWI, as motivating the need for new urban supply policies, among them groundwater reallocation. As it turned out, these projections were within the ten percent of the actual change in consumption. Jordan’s actual municipal and industrial (M&I) consumption grew more slowly than projected, but still increased by 78% by 2016 (from 275 MCM/yr (World Bank, 2001) to 490 MCM (FAO, 2016)). The absolute increase in consumption was 215 MCM/yr, nearly a quarter of Jordan’s total water usage in 1998.

Increasing population and economic activity drove the increase in urban water demand. Jordan’s population doubled from five to ten million between 1998 and 2018, partly driven by two refugee crisis (the 2003 Iraq War and the Syrian Civil War) and partly driven by natural fertility. Jordan’s GDP quadrupled over the same period, in real terms. Jordan’s water efficiency by GDP therefore roughly doubled (although for most industries water supply is irrelevant). These demand drivers are common in other reallocating countries (Garrick, 2019).

The largest source of M&I water has always been groundwater in Jordan, but the aquifers these northern cities had previously relied upon were in a state of overdraft already by 2001. The Amman-Zarqa aquifer was being abstracted at 215% of its mean annual recharge rate (MWI 1997, quoted in Venot and Molle 2008). This overdraft was caused by both highland agricultural use and M&I use. Wells operated by the Water Authority of Jordan (WAJ, an implementing body of the MWI), had started to fail in the Amman-Zarqa aquifer. As one World Bank report stated in 2001 “The bulk of (…) 86 MCM/year until 2010 and a further 36 MCM/ 2020 – will have to come from reduced abstraction for highland agriculture. If this reduction does not materialize, there is a risk of completely losing some aquifers to almost irreversible salinization of the groundwater stocks” (World Bank, 2001). IN 1998 and 2007 two algae blooms reduced supply to parts for Amman for weeks (interview with MWI policymaker, interview 9). The shortages prompted public displays of discontent with the government.

**Policy Responses to the Rising Water Needs Discussed After 1997**

In the decade after the 1997 tariff law, policy makers at the MWI, USAID Jordan, and the World Bank described in detail available policy responses (Scott et al., 2003; Salameh et al. 2013; Chebaane et al. 2004; Pitman, 2004; El-Naqa and Al-Shayeb, 2009). Alongside inter-sector reallocation, they considered wastewater treatment, water-use efficiency, transboundary negotiation and supply augmentation. Jordan has energetically attempted each of the four strategies, but none entirely removed the need for reallocation. We sketch these policies for context, but the thesis concerns how reallocation was carried out once a strong coalition supported it, not whether it was actually necessary.

Water reuse, primarily through treating wastewater, was widely implemented. By 2014 Jordan was recycling 123 MCM of water per year and the MWI projects that the flow will reach 240 MCM by 2025 (MWI, 2016). However, many Jordanians see using treated wastewater (TWW) as religiously forbidden (Interview 13 with academic), making it unpopular among agricultural users and off the table for municipal use.

Increasing the efficiency of water use, in both irrigation and municipal use, is widely proposed (Pitman, 2004; Scott et al., 2003). Unfortunately, increasing the efficiency of agricultural water use may actually increase water consumption where land is not a limiting factor (as is the norm in Jordan), so no overall savings are likely (Zeitoun et al 2012; Perry et al. 2009; Salman et al. 2018). Increasing urban efficiency could alter Jordan’s reallocation drivers, but that question is beyond the scope of this paper. In writing and interviews policy makers highlighted the importance and success of efficiency improvements, while maintaining the efficiency did remove the need for reallocation, given the strength of the demand and supply drivers.

Jordan’s transboundary water policy has not strongly affected the reallocation drivers, excepting groundwater treaty between Jordan and Saudi Arabia in 2015 after reallocation policies had been implemented, discussed below (Muller, Muller-Itten and Gorelick, 2017). Moreover, the recent Yarmouk Hydropolitical Baseline study found that failure to account for groundwater resources increased conflict in Jordanian-Syrian negtiations on the Yarmouk (Zeitoun et al., 2019ab).

*Arguments for Groundwater Reallocation*

For the MWI, the World Bank, and USAID, groundwater policies reducing agricultural abstraction was necessary to meeting Jordan’s M&I requirements, although many social actors including the Ministry of Agriculture and the parliament opposed reallocation (Zeitoun 2012). The World Bank, the MWI, and USAID all argued that efficiency increases, and surface water reallocation alone were unlikely to make up for the decline in fresh groundwater and rising demand (World Bank 2001; Scott et al., 2003).

The World Bank wrote in their 2001 Water Sector Review Update “Irrigation use of Disi groundwater was to be reduced (…) Government policy calls for a massive reduction in abstractions by highlands pumpers. The bulk of the projected reduction in abstraction of renewable groundwater – by 86 MCM/year until 2010 and by a further 36 MCM/year until 2020 – will have to come from *reduced abstraction from highland agriculture*” (World Bank, 2001: 8 emphasis added). The World Bank’s assistance evaluation was still more explicit

“Increasing groundwater withdrawal is contrary to government’s stated policy. (…) However this intent is thwarted by an unwillingness to apply regulations for agricultural water use which has led to excessive withdrawal for agriculture. Not only is this in direct competition with urban consumers, it also increases pumping costs (…) The only way to cut the overdraft is to reduce agricultural use and increase water use efficiency. (…) the current system of prices is too low” (Pittman, 2004: 8).

The same document goes on to argue that urban users and agricultural users should pay the same (higher) price for water. A MWI policy maker who was involved in these negotiations stated “The idea of the World Bank and the international organizations to solve the water problem [was] to take the agricultural water”.

Although the MWI disagreed with the methods of reallocation proposed (discussed below), they did agree that some reallocation was necessary. A scientist at the Ministry of Water and Irrigation stated “The ministry does not like to use the water for agriculture. We are a Ministry of Water and Irrigation, but our main target is to provide water domestic use” (Interview 11). *Facing Water Scarcity In Jordan*, which Hazim El-Naser co-authored while minister, emphasises the costs to stability and the rural poor of reallocating groundwater out of agriculture, but supports reallocation in vague terms. They instead supported a different strategy of reallocation (discussed below)(Macoum and El-Naser, 2001: 107; Interview with MWI policy maker, interview 9). In general, the MWI was more concerned about the side-effects of reallocation than the World Bank or donor agencies, but still found it necessary in some forms.

Most of the donor community supported the World Bank position. USAID’s deputy director for the Water Resources and Environment Office wrote in a scathing report in 2008 that “63% of fresh water supplies go to agriculture demonstrates a conscious (…) GOJ decision to short domestic and industrial water, regardless of health and economic implications.” (Hagan: iii). This document also implies that Hazim El-Naser, having left the MWI in 2005, should be reappointed. GIZ and the FAO have both also released documents supporting reallocative policies (Mesnil and Habjoka, 2012; Salman et al., 2018). Zeitoun et al. (2012) exploration of interest groups for and against demand management (reallocation are a subset of demand management) placed the donors as the most in favour social group. However, the many development agencies working in Jordan sometimes led to policies against rural-urban reallocation (Interview with MWI policy maker, interview 9).

Ultimately, for the World Bank, the MWI and most donor agencies the urban supply issues required policies to constrain the agricultural use of groundwater for the express purpose of protecting or increasing supply for the M&I sectors. However, despite this consensus there was strong disagreement about how water should be reallocated and, critically, who should be dispossessed.

Outside of the aforementioned, many important political actors remained strongly opposed to reallocation (Keulertz, 2014; Zeitoun et al., 2012; Hagan, 2008; almost all interviews). Agricultural elites, farmers, the Ministry of Agriculture and perhaps even the general public remained opposed to agricultural to urban reallocation (Zeitoun et al., 2012). Powerful political families with interests in agriculture resisted both discussion and implementation (Keulertz, 2014). The parliament, disproportionately drawn from rural areas, opposed increases in tariffs and tariff collection (Yorke, 2013: Yorke, 2016). Families within the “shadow state” such as the Masri family strongly opposed response plans despite urban water shortages (Keulertz, 2014).

*Two Reallocation Strategies*

This section describes two reallocative strategies which were proposed by the World Bank and the MWI, respectively, and were heavily debated within the pro-reallocation camp in the period between 1997 and the reappointment of Hazim El-Naser in 2010. It begins with a brief description of the policies which had been implemented at that time.

From 1997 to 2010 (when Hazim El-Naser was reappointed), water tariffs on agricultural groundwater had been passed into law, but were not enforced. At the insistence of the World Bank and the German Kreditanstalt fur Wideraufbau Bankegruppe (KFW), the tariff law was passed, price controls for crops were terminated, subsidies for wheat and barley were removed, and pastoralist subsidies were cut (affecting Jordan’s poorest farmer group). Meanwhile, several protections remained in place, including protective tariffs on some low-water-efficiency goods such as bananas (Pittman 2004; Hussein, 2019). Furthermore, the Jordanian government refused to raise the water tariff to the World Bank’s recommended level leading to KfW cancelling a portion of their loan.

After the 1997 tariff law, the lobbying farmers succeeded in amending the law to increase their allowance of free water (after which the tariff begins) to 150 kcm/yr. Collection of the tariffs was lax and allowed to be compromised without a forceful response from the MWI until at least 2006 (Venot and Molle 2008). USAID and the World Bank both perceived the lack of implementation and further reform to constitute mismanagement and abandonment of the critical need for reallocation. This mounting need and perceived inaction set the context for the following policy debate within the pro-reallocation groups.

*Reallocation by market forces in the northern highlands*

The World Bank and USAID both pushed for the liberalization of the water sector. With fuel subsidies removed and a tariff on all groundwater use, unprofitable farms would close reducing aquifer overdraft, and therefore increase M&I supply. Three main types of policies were recommended: the removal of subsidies, direct or indirect, for irrigated agriculture in the highlands, the application of volumetric tariffs for farms to internalized the externalities cost by over pumping, and the outlawing of new farming projects or wells. We refer to this suite of policies as the market-northern solution, because it advocates increasing the cost of water and focusing on the renewable aquifers of north Jordan. The clearest statement of this position was made by the World Bank

“[overdraft reduction] is thwarted by an unwillingness to apply regulations for agricultural water use which has led to excessive withdrawal for agriculture. (…) the only way to cut the overdraft is to reduce agricultural use and increase water use efficiency. The most effective way to do this is through pricing.” (Pittman, 2004: 7)

to which the reduction of indirect subsidies through energy, tariffs, immigration visas was added (Naber, 2017).

Advocates of this policy most frequently cited economic arguments for reallocation (Pittman, 2004; World Bank 2002; Hagan, 2008). They cited the small portion of the Jordanian GDP in agriculture. Because the northern aquifers (Azraq, Amman-Zarqa, Yarmouk) have large rain infiltration, they are renewable and can be stable, energy-cheap supply for Jordan’s M&I needs indefinitely. As the World Bank pointed out, hundreds of millions need not be spent on megaprojects like the Disi pipeline or the Red-to-Dead Conveyance if drastic reductions in agricultural are made. Furthermore, accepting the degradation of Jordan’s only renewable aquifers reduces future choices available, and makes energy intensive megaprojects more likely in the future. Also, advocates argued that farm shut-down are inevitable, sooner or later, as salinization and energy costs make farming uneconomical (Hagan, 2008).

*Reallocation by targeted expropriation and megaproject in the south*

The MWI counterproposed the Disi pipeline, as both a reallocation and an expensive supply enhancement. The GoJ began advocating the pipeline the 1990s (Schiffler et al, 1994). In 2003 the MWI under Hazim El-Naser submitted a proposal for credit to the World Bank to construct a pipeline for Jordan’s far south Disi aquifer to Amman, for M&I use (Macoum and El-Naser, 2004). The project was intended as a supply enhancement in that it would increase abstraction from the aquifers (by 40 MCM at inception). But it was also a reallocation, because the MWI proposed to shut down all farming in the area for reallocation (by 60 MCM at inception).

In the 2004 proposal, the MWI promised to shut down all agriculture in the southern desert to compensate for increased pumping to northern cities (Interview with MWI policy maker, interview 9). However, they did not highlight their intent because if the project did not go forward, proposing the expropriation would isolate them politically too early. The 2004 summary proposal contains two Sankey diagrams, showing the rerouting of all southern aquifers to M&I. They also describe the concessions as a threat to the aquifer, implying it will be dealt with. The actual statement that the contracts will be closed is found on page B-118 pf the full proposal. Macoum and El-Naser (2004: 114) close their proposal with two statements that justifying the Disi expropriation solution over the market-northern policies:

“In the face of resistance of well owners by Government to meter and regulate water use, would a strategy based on a more cooperative approach have any greater prospect of success? (…) In a situation where water throughout the arid Middle East is allocated by administrative decree rather than pricing and market forces, how should policy best move increasingly limited water resources away from traditional low value agriculture toward more economically productive uses?”

This statement critical question. Why was the MWI unwilling to close farms through markets and licensing in the renewable aquifers in northern Jordan, while advocating shutting down farms in the south?

The MWI preferred the Disi transaction in part because it satisfied multiple stakeholders. Firstly, most workers concessionary farms were not Jordanian but Egyptian migrant workers (Farms in North Jordan also hire some Egyptian workers, but their visa-granting powers were reduced around 2012 (AL Naber, 2017). Therefore, closing farms there would not displace or impoverish Jordanian farmers, and thus political instability (Interview with policy makers at MWI, Interviews 9 and 5). Advocates of Arab food autonomy were pleased because the climate of the southern region is hotter and dryer than the north, increasing irrigation losses to evaporation. Pumping the water north then recycling it as TWW therefore indirectly increased yield. Meanwhile, popular discontent with the project had been created by repeated public condemnation of the concessions from the MWI, including former minister Munther Haddadin and a lawsuit brought by Hazim El-Naser, professors of geology, and even medical doctors with public health concerns (Ferragina and Greco, 2008).

Further, the MWI argued that reallocation by expropriation in Disi was within the capacity or will of the state, while the market northern strategy was not. The Disi reallocation had lower transaction costs and easier enforcement. The government had only to strike a deal or expropriate four wealth families, rather than negotiate with a large number of socio-economically diverse farmers (Interview with MWI policy maker, interview 1). Once closed enforcement and surveillance was low cost, as farms could be banned entirely rather than forced to pay taxes. Furthermore, “although such heavy political support can be effective in giving a campaign initial momentum, it cannot be sustained and success may depend more on convincing well owners to cooperate than trying to enforce the rule of law at the margins of its reach” (Macoum and El-Naser, 2004). In effect, Macoum and El-Naser (2004) argued that a broad coalition could be created against a distinct set of farms to permanently close them, while taxes and incentive structures could be slowly circumvented and corrupted over years. In the next section, we trace the implementation of the market-northern policies and the Disi reallocation, finding some support for this prediction.

*Why not buyouts?*

Buying out the farmers in the northern aquifers was occasionally discussed by pro-reallocation actors, but it did not near implementation. Firstly, buyouts would be prohibitively expensive (600 million JD to buy out a quarter of the existing wells, according to MWI policy maker, interview 9). Secondly, buyouts would displace the rural poor, which was unpopular from a stability perspective. In response USAID suggested a government stipend for all Bedouin herders. Unfortunately, this type of poverty reduction via transfer payments (rather than government employment) is rare in the Middle East (Hertog, 2017). The USAID paper proposing the subsidy prefaced it with “Though this may be heresy” (Hagan, 2008: 35). Furthermore, buyouts required trust between the government and northern farmers and effective surveillance of farmer adherence to agreements. Because land is not a limiting factor to agriculture in most of the highlands, buyouts or some water market designs could incentivize further water grabbing by new farmers (Molle et al. 2017).

**Implementation of the Market-Northern Policies**

After the reappointment of Hazim El-Naser in 2010, supported by USAID and other donors, the MWI intensified their efforts to reduce or constrain agricultural abstraction in the northern highlands. The MWI received technical assistance from USAID and GIZ, and political support from the Prime Minister for its enforcement. The MWI developed creative methods to compel payment. Despite the stronger response and political support, the MWI remained unwilling or unable to extract tariffs which would close farms. Enforcement has focused on preventing the expansion of the agriculture. In addition to reviewing past evidence we trace the implementation of remote sensing as a mechanism for water estimation and show that the technology was turned away from water accounting toward detecting new illegal wells.

*Characteristics of northern highlands aquifers*

All of Jordan’s renewable aquifers with MWI-defined safe yields above 20 MCM are found in the northern highlands (Al Karablieh and Salman, 2016, quoted in Molle et al. 2017). The total MWI-defined safe yield was 223.5 in 2015. The most important basins are the Yarmouk basin in the far north, the Amman-Zarqa basin which runs from beneath the capital to the Syrian border, the Dead Sea basin south of Amman, and the Azraq basin in the desert east of Amman. Much of this region has seen declining water tables and increasing salinity rates caused by over-pumping. A 2013 study by US geological survey projected that average saturated aquifer thickness would decrease 30 to 40 % by 2030 and reach zero in five percent of evaluated locations (Goode et al.). These trends have for decades affected both farmers and the well-drilling staff of the MWI. A farmer once interrupted our interviews at the MWI to discuss his multiple well failures (Interview with MWI policy maker, interview 11).

Due to its distinct agricultural history, the northern highlands have many small and medium size farms, owned by elites and non-elites. Northern farmers have a closer cultural relationship with farming than the Bedouin in the Disi area. The highlands have a long history of agriculture, primarily rainfed fruit trees prior to the 1960s (Al Naber, 2017). From the 1960s to the 1990s the state supported increased agriculture and settlement of the Bedouin. The combination of low energy costs, improving well drilling, cheap and fertile land and cheap Egyptian labour led to a boom in production and profit in the 1990s (Elmusa, 1994). Agricultural profitability has since declined. Interviewees in the MWI and Jordanian academia emphasized the socio-economic diversity of farmers, particularly the presence of small, marginally productive farms. This diversity has been confirmed in the Yarmouk and Amman-Zarqa Basins by Venot and Molle (though data collection was in 2003), and more recently by Naber and Mesnil and Habjouka in 2013. Farmers are divided between prestige farms, usually growing unprofitable olive trees, small bedouine vegetable growers, and large farms producing cash crops such as grape, stonefruit and alfalfa, which have higher margins. Bedouin shepherds are seen much less in official statistics but are a constant feature of the landscape (Authors personal hiking/observation).

*Limited Regulation in the Highlands, 1997 to 2010*

From 1997 to 2010, the tariff and licensing system rapidly deviated from the vision of the World Bank. In 2004 tariffs were reduced when current well-owners were granted a generous quote of 150 Km3 before fees began, and an 92% fee reduction for the next 50Km3. This reduction was granted due to farmer lobbying, as well as an inducement for registration of the wells and to prevent mass non-payment. Attempts by the MWI to partially remove the second block discount faced successful opposition from the parliament until 2018 (Interview with MWI policy makers, interview 9).

These low fees and high-quotas meant that even if fees were collected, they would not cause significant water savings at the time (Venot and Molle, 2008). The World Bank advocated for tariffs with no quotas to drive the most unproductive crops out of production (often olive trees). However, the generous quotas effectively exempted these unproductive farms if they registered because the unproductive farms tend to be small. The tariffs fell on larger farms, which are more profitable. For these farmers, increasing water use efficiency and expanding the cropped area (illegal but unenforced), was the financially optimal strategy. However, expanding area and increasing efficiency actually tends to increase groundwater depletion. The water which is wasted on an inefficient farm often falls back into the aquifer, so greater efficiency without less consumption degrades the aquifer faster (while increasing profitability). This early quota system therefore mean that the small non-profitable farms were unaffected but the profitable farms could respond by, perversely, increasing aquifer depletion.

The volumetric tariff system became increasingly complicated, with new exemptions to wells registered at different times. In 2014, Al-Naber found 5 different legality categories for wells with their own quotas and tariffs. This Kafkaesque system results partly from the need to constantly create new incentive for registration, as the number of wells is too high to police without some cooperation. These quotas and registration timelines pushed regulation toward “illegal wells”, defined as wells which had not regulated during the previous deadlines. This situation is not unique to Jordan (Molle and Closas, 2017).

Implementation was sporadic, at least until 2012. The MWI only assigned an employee to collect fees in 2005 (Venot and Molle, 2008). As of 2006, only 25% of farmers in the eastern part of the Amman Zarqa Basin were paying any bills (Molle et al., 2017). Negotiations led to a reduction of arrears to 30% of their value in 2010 (Ibid). Tampering with volumetric meters by farmers is described as routine by every investigation (Molle et al, 2017; Al Naber 2017; Hagan, 2008, Venot and Molle, 2008). This lack of implementation resulted partly from social pressures inside the ministry, as anti-reallocation actors sanctioned pro-reallocation discourse within the water sector (Zeitoun et al. 2012). USAID staff reported that water sector officials refused to discuss the topic for fear of their careers (Hagan, 2008). Lax implementation failures led USAID to openly discuss withdrawing donor support in Jordan’s water sector.

*Strengthened Regulation and the Illegal Wells Campaigns*

In 2012, Abdullah Ensour was appointed prime minister and Hazim El-Naser was reappointed head of the MWI. With Ensour’s support, El-Naser intensified the enforcement of licensing and tariffs and publicly confronted anti-reallocation elites within the state. Despite political support, the new campaign did not match World Bank’s vision for reallocation in which low-productivity farms were forced to close. Instead preventing the spread of agriculture and extracting tariffs remained the main objectives. Farmers continue to resist and circumvent the tariffs and licenses, such that the cropped area increased.

After at least 2012, protecting highland groundwater for future M&I was openly discussed in the northern highlands. Hazim El-Naser publicly advocated for reducing water use on television advertisements (Al-Naber, 2017). Criticism of the MWI from the parliament led to an exchange of gunfire between gendarmes protecting El-Naser on the way to close a well (interview with MWI policy maker, interview 9). In 2016 Hani Mulki was appointed prime minister and was less willing to defend the MWI’s policy (Ibid). Despite the departure of Ensour and El-Naser, by 2019 all management-level MWI staff interviewed spoke about protecting drinking water (referring to M&I supply). Contrasting with Hagan’s description of sanctioned discourse in 2008, the bounds of acceptable discourse did shift permanently.

The MWI began a well-publicized campaign of shutting down illegal wells and fining farmers for violations (Al-Naber, 2017). In 2014 the MWI added a new category of illegal wells with a higher tariff of 35 fils (.04$)/m3, and no quota. The MWI began denying other government services to farmers with outstanding debts, like the ability to sponsor visas or register land sales. They confiscated drilling equipment caught operating without licensing. They published the names of delinquent well owners to embarrass them into paying. According to Naber “the Minister has decided to use dynamite to close wells, to ensure that they cannot be used again, while ordering pictures to be taken for each case” (Al-Naber, 2017: 138).

The best evidence of state commitment is the resistance strategies farmers developed in response. Farmers applied for well-cleaning licenses, then used them for deepening and drilling. They transferred water by pipe between farms to disguise its origin. Bribing and intimidation increased, to the extent that one farmer attempted to bribe an MWI scientist on a fact-finding mission (Interview with MWI staff, interview 11). One farmer hid a well beneath his bed (Al-Naber, 2017). Resistance to the policy also increased at the lower levels of the WAJ, leading lower-level basin officials to refrain from reporting new wells to prevent their destruction (personal communication, 2018).

Despite the stronger enforcement of illegal well policy, the MWI did not transform the negotiation of water tariffs in this period. Volumetric meters became less useful in the 2010s due to both tampering and the logistic challenges of checking thousands of meters. Instead water usage is usually calculated via a table of crop-types and water-requirements per area, created by the Ministry of Agriculture. The local WAJ office sends engineers to measure (or estimate, given their time constraints) the cropped area for each crop then multiply by values in the table. Staff of the WAJ and the MWI know that this table systematically underreports water use.

In 2018-19, the USAID-funded the Water Management Initiative (MWI) taught remote sensing techniques MWI and WAJ staff for water accounting. The WMI measured water use in the Azraq aquifer using Surface Energy Balance Algorithm for Land for Evapo-Transpiration (SEBAL-ET), a technique which calculates crop water use from surface temperature, albedo and air temperature (Sanz et al, 2016: Gobbo et all, 2019). The study found the official MWI figures underestimated farm water use 60 MCM to 35 MCM, the difference itself equal to the aquifers safe yield (personal communication). Because SEBAL relies on surface energy balance, it accounts for under-irrigation, as is common on unprofitable farms (Al Naber, 2017). Their estimate was 5 standard deviations from the ministry estimate. Were it implemented, the remote sensing technique would likely raise fees and also remove opportunities for WAJ engineers and basin managers to recalculate fees. During interviews redirected toward identifying hotspots of increasing water use, where illegal wells are likely away from water accounting. When asked why not calculate the fees using the SEBAL-ET instead of the crop table, one basin manager stated “I cannot use the remote sensing data without violating regulations of the Ministry of Agriculture. We recommended [changing to RS] (…) if they do not want to listen that is another thing”. Another basin manager responded “there would be a revolution (*thawra*)”. It is unclear if he meant farmers would simply stop paying the tariff entirely or general political instability, or both.

*Evaluating the tariffs and licensing as reallocations*

Government records show reductions and stagnation in groundwater extraction for irrigation (Karablieh and Salman, 2016; interview with MWI policymaker, interview 6), but these records contradict independent studies that find consistent expansion for the cropped area for decades. Most likely top-down pressure on basin managers, who lack the tools or mandate to dramatically change farmer behaviour, caused distortions in the data (Molle et al. 2017).

None of these changes are designed to close existing unprofitable farms. Since 2004, the quotas and tariffs for farms registered early have not increased, including most farms in the Amman Zarqa Basin, which has the highest recharge rate and is exploited at 190% its safe yield (MWI, 2017). Both the strengthening of the MWI in 2012 and the remote sensing technology resulted primarily in policies targeting illegal wells and fee non-payment. The 2014 law created a tariff for the latest registering wells of 35 fils (.05$), intended as a steep penalty to scare farmers into registering and deter new entrants. This tariff is less than the original World Bank proposal, without counting for inflation. It is also just 10% of the energy costs of Disi water alone. Ultimately the effect of the policy is to slow or stop the expansion of agriculture, and not to close unprofitable farms. One MWI staff member, when asked if wells are closed “I don’t think there are closing of wells in Jordan, even if these wells are illegal. If the government finds illegal wells, all the government can do is turn it over to the courts. If the well is completely drilled and the farmer is already using it… I have never heard of any [in use] wells being closed except in the Disi area.”

Since 2012, the MWI has been strengthened politically and technically, but it has never adopted the World Bank plan of closing unprofitable farms. Either the pro-reallocation camp in Jordan is not interested in closing farms, or that they cannot build a strong enough coalition to do so. Interviews with ministry staff supported both explanations, one quote summarizes a repeated theme:

“When you talk about water we are also talking about rural livelihoods. (….) it’s hard to make a targeted policy to reduce export agriculture (…) the policies may end up on poor people and not on the exporters. If you have a lot of poor people that you are fighting [their] livelihoods, then you will have a difficult time coming to an agreement and making policies (…) We do want to use the water for the most valuable thing, but you also need to protect these communities.”

This narrative corroborates reports of lower level WAJ staff keeping well locations from their superiors and the request to photograph destroyed wells. The Highland Water Forum 11th consultation (a GIZ-funded participatory governance project) records an instance of farm-closings being struck from the discourse. A resolution to study “closing down unfeasible agricultural investments regardless of their legal statuses” was struck and amended to describe only violators. The MWI, as an institution, is hesitant to close unprofitable farms, and doing so would encounter stronger political opposition. Profitable farms, which tend to be legal (Interview with MWI policymaker, interview 9), were expected to survive the original World Bank tariff of 60 fils (.07USD)/m3, assuming they are asked to pay the full tariff.

In 2012, three theories could have explained why tariff and licensing policies have not closed farms or reduced agricultural consumption, or prevented increasing agricultural extraction, as occurred. The first is that few relevant policy actors are affected by the problems of urban supply (expense, poor quality, rationing and future supply shortages), so that the pro-reallocation group is unable to launch strong demand-management policies. The second is that a lack of interest from the leadership of the state, particularly the prime minister, is responsible for the weakness of regulation (Hagan, 2008). The third explanation is that enforcement of licensing and tariffs faces steep practical challenges and high costs. With new information from the past 7 years of enforcement, we can constrain these theories. The fact that after 2012 under Abdallah Ensour and Hazim El-Naser the MWI advanced on deterring illegal farms and incentivizing efficiency, not closing non-viable farms, suggests political will was not a decisive factor. If enforcement were the deciding factor, the SEBAL-ET system could have been used for water accounting, rather than identifying illegal wells. Ultimately strong policies to close unprofitable farms and thereby reduce over-abstraction in the highlands did not occur primarily for reasons of political economy and interest group relations.

This conclusion is consistent with most developing countries facing groundwater overuse. Interest groups are frequently aligned with preventing rural poverty, providing jobs, and increasing agricultural production, so resistance to conservation of groundwater is not caused by unique attributes of Jordan’s political economy (Molle and Closas, 2017). Other aspects of agricultural policy are strongly conditioned by patronage, rentier and shadow-state features of Jordanian politics (Mustafa, Altz-Stamm and Scott, 2016; Hussein, 2018; Yorke, 2013; Keulertz, 2014; Yorke 2016). From a comparative perspective, Jordan’s regulations were unusually comprehensive and well-supported politically since 2012, and MWI interviews suggest that protecting M&I supply is the cause. But even comparatively strong demand management could only slow the expansion of groundwater irrigation. M&I needs did not rearrange interests of the state sufficiently to enable strong groundwater regulations, except in partially deterring agricultural expansion.

**Implementation of the Disi Reallocation**

This section argues that reallocation by expropriation in the south succeeded in transfer a significant portion (at least 30 MCM/yr) from agriculture to M&I use. First, we summarize the history of desert agriculture on the Disi. Then, we describe the conflict between the MWI and water users in Mudawarra leading to the farm closures in 2013. We use remote sensing to show that the shut-downs did occur and have continued, but several farmer groups were exempted. Finally, we discuss the role of urban water need in the farm shut-downs.

*Context*

The Disi Aquifer is a fossil aquifer in Jordan’s south-eastern desert, straddling the Jordan Saudi border, near tourist destination Wadi Rum. It also extends deep into Saudi Arabia as part of the Rum-Saq-Tabuk system, where it has enabled large-scale desert agriculture (Salameh et al. 2013). The aquifer lies near the surface and has low salinited keeping pumping costs low and making it attractive to water users (Vengosh et al. 2009). Exactly how much water can be pumped from the Disi aquifer for how long is subject to debate, but estimates range from 80 MCM for 50 years to 100 MCM per year for 200 years in the MWI’s public statements (Ferragina and Greco 2008; Salameh et al. 1999). In 2008, the Duke-University led team found that while the water is chemically pure, it contains active radium nuclides 10 to 20 times in excess of EU guidelines (Vengosh et al. 2009).

In 1984, the government of Jordan granted licenses to four agribusinesses to rent land on the Disi, to be renewed by the Ministry of Finance every 5 years. Previously the water was used solely for the M&I needs of nearby Aqaba and small farming projects for the local market. The concessions were originally intended to increase Jordan’s food independence and imitate successful projects in Saudi Arabia (Yorke, 2013), and possible to establish a prior claim on the shared resource (Feragina and Greco, 2014). The contracts required half of the rented land be used for wheat and barley, but by the 2000s they produced exclusively cash crops for export (Yorke, 2013). No sources described the total land area rented. The contracts did not limit extraction nor establish any monitoring system, but annual extractions of 65-80 MCM/yr are commonly quoted by ministry staff. Most interviewees suspected that actual extraction was higher given the lack of independent monitoring. By 2013 the water table in the confined Disi had dropped by 25 meters (Salameh et al. 2013).

The concessions are owned by four well-known private families that trade support for the regime for policy influence and preferential treatment (Yorke, 2013). The largest concession-holder, the Masri family, had privileged access via shares granted the monarchy in Arab Bank (Keulertz, 2014). Each agribusiness was associated with an influential family who used political appointees to support their resource access (ibid). Former prime minister Adnan Badran was a shareholder and supported his agribusiness in a tax dispute, creating a public scandal (Yorke, 2013). Described by Yorke, 2014 “special interest groups we able to use their personal positions to lobby for access to water for their farms – which provided employment for their followers, to manipulate political ties to the centre, and (…) forge coalitions with citizens who would otherwise oppose their interests”(68). However, the concession holders in Mudawara lacked a local non-elite support base, making them more vulnerable to expropriation.

*Farm Closures and the Disi-Amman Conveyance*

By the start of construction in 2008, the evidence was clear that sharing the aquifer between agricultural and M&I consumption would undermine the expense of the project and the quality of the water. The freshwater in Disi, where the MWI eventually placed wellfields, lies underneath the saline Khreim aquifer, which may leak into the freshwater. The MWI’s estimates of aquifer volume were contested by lower estimates from geologists (Salameh et al. 2014). As MWI was already exaggerating its studies to claim that the aquifer could supply 125 MCM for 50 years, sharing the aquifer with agribusinesses extracting some 70-80 MCM would jeopardize the billion dollar investment.

Jordan launched an unsuccessful tender call for construction contractors in 2001, due to low funding (Ferragina and Greco, 2014). In 2002, the concessions expired, and the Ministry of Finance renewed them, showing a lack of commitment to creditors, sorely needed after the tariff conflicts(Pittman, 2004). In 2006, the bid was relaunched and finalized with GAMA Energy for 1 billion USD, not including operation and maintenance. Much of the funding came from Jordan’s creditors other than KfW and the World Bank (Arab Banking Corporation, 2009): the US provided 250 million USD from the Overseas Private Investment Corporation (Development Finance Corporation [formerly OPIC], date unknown), AFD and Proparco together provided 150 million USD (AFD, 2008), and the European Investment Bank contributed 166 million USD (European Investment Bank, 2009). At least 100 million further USD were provided by the Jordanian Social Security company (Ferragina and Greco, 2014).

In 2008 the government offered the four agribusinesses farmland in Sudan that had been acquired by a military-owned company, but was refused (Keulertz, 2014). In 2009 the government publicly committed to withdrawing the concessions, only to renew them a year later (Keulertz, 2014). In 2013, completion of construction, the farms operating in the Mudawarra area were forced to close, after lobbying by Hazim El-Naser with the support of Ensour. A MWI policymaker described the debate “No one wanted to cooperate. Not the Ministry of Finance, not the Ministry of Agriculture, because they think supporting farmers is their mandate, the influential people of the farmers. They knew everybody and they kept hammering” (interview 9).

The final deal closed the three farms in Mudawarra in 2013. They remain closed as of 2019 (see figure 1). Despite the lateness, Mudawarra is the most impactful groundwater reallocation identified in Jordan. The government demonstrated commitment in a subsequent agreement with Saudi Arabia banning agriculture in Mudawarra and some 40 kilometres south into Saudi territory (Eckstein, 2015).

The pipeline was both supply enhancement and reallocation. The MWI has stated their extraction before shut-down was 30-35 MCM, but staff noted that this number comes from the companies themselves, who had strong incentives to underestimate consumption to keep tariffs and publish pressure low. The WMI SEBAL-ET study in Azraq found extraction double the WAJ numbers, so 35 MCM/yr is likely an underestimate. In any case, the reduction in agricultural extraction is dwarfed by the increase in M&I extraction by 125 MCM/yr (MWI, 2017). A monitoring well in the area shows a tenfold increase in water level decline in 2013, corroborating the supply enhancement (MWI and BGR, 2019).

As figure 2 shows, only the farms in the Mudawarra area were closed. In the Disah area, some 40-50 kilometres away, locally owned farms, the Masri-owned farms, and the expansive gardens for the hunting lodge of an Emirati Sheikh continued. Ministry policymakers argued that these wells are too far to affect the M&I fields and that the Masri family was too influential to shut down the farms. In 2009 a Masri family member was appointed Minister of Agriculture, their original concessions were the largest (Keulerts, 2014), but distance to the well fields is also plausible.

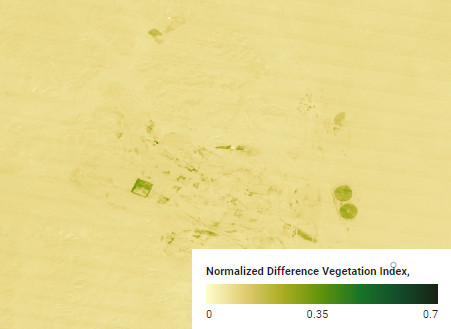
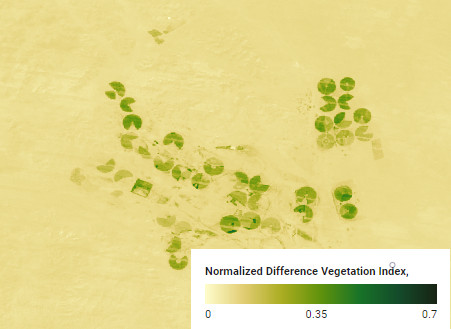
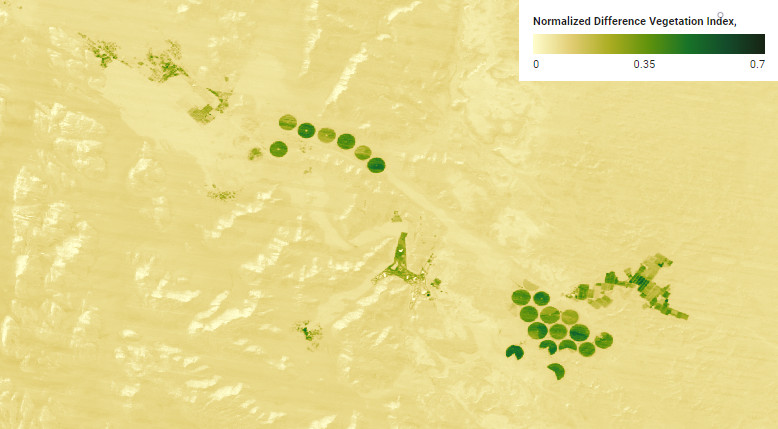
 

Figure 1: NDVI map of Mudawarra (confined Disi aquifer) in 2012 (left) and in 2014 (right)/ The massive reduction in the cropped area confirms that the farms were closed. Note the reduction to just two functioning fields. This conforms to accounts from MWI interviewees and to a scholar.



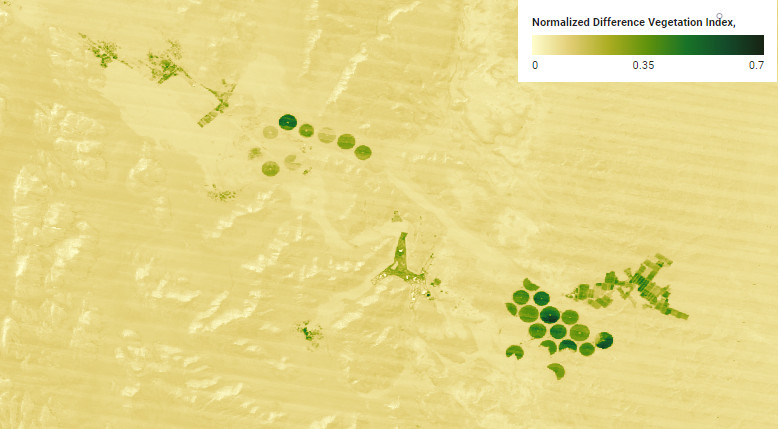


Figure 2: Disah area (unconfined Disi) in 2012 (top) and 2014 (bottom). The town of Disah in the top left. Locally owned farms were not affected. The three pointed object near the centre is the hunting lodge, which was also exempted. The Rum company (owned by the Masri family) was mandated to reduce their water use form 35 MCM to 15 MCM. Some change in the cropped area is visible, but should not be used to infer compliance/noncompliance. NDVI does not correlate uniformly with water use and noise due to weather, seasonal variations, and LANDSAT’s own schedule limits comparability.

*A broad coalition supporting closures in Disi-Mudawarra*

Without the threat of instability in East Amman to escalate the issue, the Mudawarra closures would not have occurred. However, rescinding the Mudawarra concessions had the lowest political costs of all the available sources: there were few locals for the elites to enter coalition with, the export agriculture was unpopular with the food-independence lobby, the transaction and enforcement costs were low, and the supply increase of 80 MCM relieved pressure on northern aquifers.

The threat of instability in East Amman from water shortages did increase interest in the issue from the prime minister according to MWI staff interviews. One policy-maker stated “If people are out of water it will cause instability (…) burning tires int the street. We went through such cases [in] 1998, 2007, major events that made Jordanians very anxious.” Even geological faculty and medical doctors began taking strong public stances in the conclusions of their publications, explicitly advocating the aquifer be reserved for M&I use (Jasem et al., 2011; Salameh et al., 2014). Public discussion of the shadow state in the Jordan Times embarrassed the government as well (Namrouqa, 2012). A further water shortage in East Amman, particularly after the Arab Spring, posed a meaningful stability threat, strengthening the MWI’s arguments (interview 9). The urban water shortage in the summer of 2007 acted as a ‘trigger’ for the reallocation, as described in Garrick et al. (2019). Once the pipeline was built, not closing the nearby farms would have compromised the massive investment (Interview with MWI policymaker, interview 11).

The farm closures deviate from Jordan’s pattern of politically-connected, wealthy farmers protecting their water access. However, it is consistent with the state’s reluctance to increase rural poverty through water policy. The staff of the Mudawarra farms were most or all Egyptian migrant workers, not local Jordanians. For the local Bedouin the largest impacts were the loss of fodder for grazing, seasonal labor, and business selling to the migrant workers (Interview with scholar). Their own farms, near Disah, were exempted. In the words of one MWI staff member “Here [in Disi Mudawarra] there were no social consequences to care about. Those were rich people no problem losing a bit of business.”

The continuation of the Disah area farms further supports that Jordan avoided “social consequences” (interview with MWI policymaker, interview 9) when selecting regions for reallocation. The Masri farms are closer to Bedouin towns and have a closer relationship to the locals (interview with scholar), which may explain their resilience. The local Bedouin farms exemption also avoided increasing rural poverty.

Even the supporters of food autonomy in Jordan (critics of virtual water policies) could support the Mudawarra farm closures. The evaporation rate in the southern desert is double that in the northern highlands due to high temperatures and low humidity (Salameh et al., 2013; interviews with MWI policymakers, interview 1). Once water is used domestically in the northern highlands in can be treated and reused with greater efficiency, in theory increasing Jordan’s effective water supply. As the Mudawarra farms practiced more profitable export agriculture they did not contribute to food autonomy.

Closing the Mudawarra farms required lower transaction costs and enforcement costs as well. One MWI policy-maker commented “The government went for the easiest solution, to make a deal with many farmers, separate farmers is not easy. It is easier to make a deal with a small number of companies. I was not there when they made this decision, but if you ask me, this is my idea.” (interview 1). Furthermore, the Mudawarra closures had low enforcement costs. Most of the farmer resistance strategies rely on disguising water sources among farms (Al-Naber and Molle, 2017). Once an area of tens of kilometres had nearly no cultivation, preventing new farmer entry is less expensive. Excepting elite conflict, the Mudawarra decisions avoided most of the pragmatic constraints on the MWI’s efforts to control agricultural groundwater, including rural poverty, transaction costs and enforcements costs.

Donors pressed for the Mudawarra closures as well. MWI staff referenced ‘triggers’ that USAID (reportedly, the loan was provided by OPIC) placed on Jordan. The MWI staff implied that the closures were required under the contract, but OPIC does not release its contracts so verification was impossible. Distrust of Jordan’s promises is plausible after Ross Hagan’s paper and Jordan’s past reneging on the privatization of its tomato factory interests to the World Bank (Pittman, 2004). But also some 250 million USD was fronted by Jordan and it’s social security fund (Keulertz, 2014), and the contract called for operations payment to GAMA whether water flowed or not (interview with MWI staff, interview 2), so the GoJ had strong reason to close the farms either way. One MWI employee even suggested reproducing the BOT model to increase political will (interview 3).

*Urban requirements and the Disi-Mudawarra closures*

Much of the desire for the Disi-Amman pipeline came from interest groups opposed to reallocation in the northern highlands and the Jordan valley, who advocate for expensive supply policies over demand management. Highland farmers and Jordan valley farmers received less competition from the M&I supply. Proponents of food autonomy increased local food production. The regime increased water supply without an influx of displaced farmers to crowded cities. But key policy-makers (at least the MWI, donors, and Ministry of Agriculture) understood that such an expensive project would require farm closures, but accepted because of the characteristics of the farms. The ‘triggers’ placed by OPIC/USAID strongly suggest that Ministry of Finance and Prime Minister, who signed the contract, accepted the farm closures. Therefore, the Mudawarra reallocation had much wider and more durable coalition than the licensing and tariffs. This broad coalition, combined with low transaction and enforcement costs, allowed expropriation to be applied and maintained over years and multiple reappointments.

**Discussion and Conclusion**

This paper has explored these two sets of policies for reallocating groundwater from agriculture to M&I use in Jordan, to understand to what extent urban requirements altered groundwater management. In Jordan’s northern highlands, the World Bank and the MWI have attempted reallocation through groundwater licensing and tariffs. The published works of the World Bank, USAID, and the statements of MWI staff show that protecting the domestic and industrial sectors was a strong motivation for the licensing and tariffs. However, the regulations failed reallocate groundwater, though they have slowed the growth of agricultural extraction. Instead, in the Disi aquifer, an explicit strategy of groundwater reallocation was not only attempted but achieved tangible and durable changes. In both cases urban requirements contributed to greater political commitment but did not overcome most structural challenges to reducing irrigation.

In the northern highlands, the World Bank advocated for the closure of unprofitable farms through a volumetric tariff system. Political resistance from rural regions, implementers, and reluctance of Jordanian policy makers to increase rural poverty, partly out of stability concerns, have redirected the tariffs toward wealthy farmers and new, illegal farms. The appointment of a pro-reallocation Minister of Water and a supportive Prime Minister in 2012 led to stronger enforcement of tariffs on wealthy farms and restrictions on illegal farms. Remote sensing technologies that could have driven up tariffs were negotiated away from water accounting due to pressure from the Ministry of Agriculture. Ultimately, reducing agricultural water use on the many small, citizen-operated farms of the highlands would require policies outside of the Jordan’s window of discourse or ability to implement. Tariffs and licensing have probably reduced the growth rate of irrigation by increasing the costs of starting new farms.

Without the Amman water crises and demand drivers, the Mudawarra closures are implausible. But closing the Mudawarra farms was unusually easy compared to farms defended by broader coalitions of interest groups. Evidence for a large impact of urban water needs would be stronger if both Mudawarra and unconfined-disi farms had been closed as Macoum and El-Naser promised (2004). Urban requirements had a moderate effect on the expropriation in the Disi. They spurred a successful and sustained reallocation but did not overcome most barriers to groundwater reallocation, as shown by the continued use in the unconfined (Disah) area.

Based on these results, reallocation drivers in low-surface-water basins does increase the probability of stronger-than-average groundwater regulations. However, the chance that regulations or expropriation will reverse consumption trends themselves remains low, based on the global experience and the small volume of reduced extraction in Jordan (Molle and Closas 2017). The value of urban supply may motivate a strong state response without overcoming the high political and practical barriers to successfully reducing irrigation extraction.

Furthermore, the rejection of cash-transfer solutions (Hagan, 2008), the preferential treatment of Mafraq farmers (Yorke, 2013) and the references to social stability suggest that political economy strongly influences outcomes. The autocratic states of the Middle East share distributional characteristics, such as overreliance on state employment, a preference for in-kind transfers rather than cash, and a high tolerance for economic distortion (Hartog, 2017). Therefore, the predictions from Jordan’s case should hold better for other Middle Eastern autocracies.

*Explaining high-cost solutions*

While the Disi-Mudawarra pipeline was an effective and durable reallocation, it was several times the cost per unit volume of other sources (except red-dead). The WAJ, implementing agency of the MWI, pays 920 fils (1.3 USD) per m3 to GAMA Energy, and charges their distributor .45JD (.63USD) per m3. The WAJ price is 15 times the maximum tariff bracket for farmers pumping over 200,000 m3, which is negotiated down anyway. Previous MWI sources were less expensive, 20% less in Azraq to 66% less for others (interviews with MWI staff, 2019). The contractual obligations to pay over 100 million USD a year are a strain on Jordan’s budget contributing to escalating fiscal difficulties (World Bank, 2019). By 20147 the WAJ had added 2.4 billion JD (3.4 billion USD) to Jordan’s deficit and the World Bank advised them to the domestic water price by 40%(ibid.).

Foreign observers have expressed surprise that even pro-reallocation actors in Jordan support expensive megaprojects (Schiffler, 1994; Pittman 2004; Greenwood, 2014; Bonn, 2013). However, the 2012-2019 period shows the limits of tariffs and licenses to achieve large reductions in groundwater use. Unwillingness to create rural unemployment at all levels of the state suggest that the World Banks northern strategy was beyond the cabinet’s ability. While the pipeline strategy was massively expensive, it was within state capacity without rewriting Jordan’s social contract. Unfortunately, easy access to foreign credit for megaprojects may delay reforming said social contract.

*Lessons for reallocators elsewhere*

These examples from Jordan resemble groundwater reallocation attempts in Chennai. In both cases both supply and demand drivers led urban water suppliers to use groundwater management to slow agricultural groundwater use (Punjabi and Johnson, 2019). Jordan also resembles the World Bank’s new proposal for ring-fencing in which “Local, city-specific aquifers can be managed at the city level, which decreases vulnerability to other users’ demands” (World Bank 2018: 12). Although ring fencing relies on managed aquifer recharge, the core advantage is that the city can create its own institutions on a specific aquifer to protect from other users. That Disi-Mudawarra conveyance effectively created a “ring-fenced” aquifer in the least populous part of Jordan.

For states which struggle to legitimate policies, targeted expropriation has advantages. Because less farmer buy-in is needed, expropriation remains effective even if the state cannot legitimate unpopular environmental regulations. Furthermore targeting agribusinesses for expropriation over small farms avoids some of the social consequences of reallocation. Expropriation may increase regime survival if it signals willingness to confront powerful individuals benefiting from unequal resource distribution, while restricting that confrontation to a narrow, pre-selected set within the elites. Albertus and Menaldo found evidence that dictators use expropriation as a commitment signal in land and banking as well (2012).

Outside of its effectiveness, the targeted expropriation strategy comes with its own costs. It exacerbates inter-regional tensions (even though locally owned farms were left, the reallocation was not popular with the Disi Bedouin). Secondly, it leads to divergent outcomes between businesses, as being located near an attractive well site for urban supply is liability for a business. As with any water reallocation, the lost employment may cause internal migration, poverty, or instability. Concentrating social consequences in one region may violate norms of fairness underlying the social contract.

Reallocators may realize some of the value of ring-fencing without the costs of targeted expropriation by regulating deep aquifers. Deep aquifer regulation might have lower enforcement costs because drilling costs are high, so illegal drillers must take on more risk. If irrigators have not yet tapped them, the prior-appropriation claims are weaker.

Most importantly, future discussions of equity and efficiency in reallocation should consider the intense political and practical challenges to reallocation. As the average costs of water increases over the coming decades and groundwater resources decline and deteriorate, the allocation of existing groundwater may become an important issue. Understanding if and how groundwater can be allocated between sectors requires overcoming distinct challenges from surface water allocation.

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