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A Rentier State under Blockade: Qatar's Water-Energy-Food Predicament from Energy Abundance and Food Insecurity to a Silent Water Crisis

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Abstract: This article investigates Qatar's sustainability crisis of the high levels of water, electricity and food use. The high levels of consumption have been enabled by Qatar's significant hydrocarbons wealth, a generous rentier state's redistributive water governance, and structural dependence on imported food and food production subsidies. The water crisis is silent because it does not generate supply disruptions nor any public discontentment. The geopolitical blockade Qatar is experiencing sparked discussions in policy circles on the best ways to ensure food security, but has only exacerbated its water insecurity. The blockade makes more urgent than ever the necessity to maximize and increase synergies among different sectors.

Keywords: desalination; water-energy-food; rentier state; redistributive water governance; Qatar; blockade

1. Introduction

Qatar and the other monarchies of the Gulf region are paradoxes. They represent some of the most arid drylands in the world, yet they feature some of the highest levels of water and food consumption per capita in the world [1]. One explanation is the presence of large reserves of oil and gas resources in these arid countries, which for long have been poorly populated. However, a rapid international review of the water and food security standards in other hydrocarbon exporting countries, such as Angola, Equatorial Guinea, Kazakhstan and Venezuela, shows that the Gulf petromonarchies (namely Bahrain, Kuwait, Qatar, Saudi Arabia, the Sultanate of Oman and the United Arab Emirates) have developed their water supply services much beyond what other hydrocarbon-rich countries have achieved, even when the latter feature much larger natural freshwater resources [2]. Broadly speaking, the Middle East region is indeed one of the most water scarce regions in the world, because of geophysical reasons on the one hand, but also because it hosts fast-growing populations and unsustainable levels of extraction of groundwater resources for agricultural purposes, despite overall decreasing precipitations and increasing temperatures [3–7].

Even if the countries in arid and semi-arid regions such as the Middle East can be very different, the fundamental challenges of water resources management aiming at ensuring a balance between

water demand and supply remain the same. What differs is the capability of the country in ensuring such balance: domestic availability of energy resources; funds for technical supply side solutions; the degree of acceptability of treated wastewater reuse; the state-society relations and the political economy and interests of those benefiting from the current status quo, are only some of the variables that needs to be considered. However, Qatar and the Gulf states constitute a specific sub-region, and arguably a unique case in the Middle East, for two main reasons.

The Gulf petromonarchies significantly differ from other countries in the region as the challenges they are facing are structurally different given the sub-region's very large reserves of energy resources on the one hand, and the extreme levels of natural water scarcity that they suffer from on the other. Qatar and the Gulf States are indeed experiencing a form of freshwater crisis, although a silent one arguably, as they are able to camouflage the advanced and rapid depletion of their underground freshwater resources by using hydrocarbons energy resources to desalinize vast amounts of seawater and ensuring their citizens never experience or perceive water scarcity or food shortages. This is then reflected for instance in their high levels of water and food consumption per capita. As shown in Figure 1 below, the particularly unsustainable nature of this situation shows the necessity of considering water and other sectors, such as electricity generation and agriculture, together when discussing and analyzing the silent water crisis of Qatar and similarly of other Gulf States. Extensive research on water scarcity taking social sciences perspectives in the Middle East focused on the Levant region [8], while research on water issues in the Gulf States almost always took engineering and technical approaches focusing on desalination plants [9], often overlooking consideration of the broader context and of the real of possibilities for policy action. Especially given the relevant role of the broader political context, namely the geopolitical blockade to Qatar from its neighboring countries, issues of water, energy, and food security needs to account for the broader political context and should not be studied merely from a technical and an engineering perspective [10,11]. Research on the impacts of the blockade on Qatar have been recently conducted, but with a focus on geopolitical, energy trade, economic and security considerations [12–14], while its impacts on water and energy security has been overlooked. The originality of this article is its multi-sectorial analysis and consideration of the broader political context to understand the causes of the problem. This is particularly needed and original because it allows capturing and including the latest developments following the blockade imposed to Qatar by its neighboring countries in the analysis. The impacts of the blockade have not been analyzed in the literature before. In doing so, this article makes an empirical contribution to the literature on water policy in the Gulf region. More precisely, and using Qatar as a case study, this paper explains how the dependence on large revenues from the international trade of hydrocarbons and the rentier nature of the state have generated a silent but growing crisis of the unsustainable water-energy-food sectors in these countries and how the latest political dynamics in the region are impacting and re-shaping the Qatari strategies towards water and food security.

The main methods of data collection and analysis deployed for this research are hydrological data; technical documentation (reports, articles, policy briefs and the new national climate change strategy); a national-scale survey data set (n = 1484) conducted in autumn 2015 on the issue of water and electricity billing by representative phone survey of adult Qataris (n = 742) and adult white-collar expatriate workers (n = 742) (as further discussed in Section 3); and semi-structured interviews of key stakeholders in the years 2017–2019 to capture the latest developments after the blockade, which were analyzed through a political economy framework and a critical discourse analysis.

This article first provides a general background context of Qatar, including the current diplomatic crisis and blockade. Second, it provides a reconstruction of Qatar's political economy of the water sector. Third, it discusses the outcome of a national survey on payments for water and electricity services. Fourth, it sheds lights on water for agriculture and food security. Finally, it provides concluding remarks.

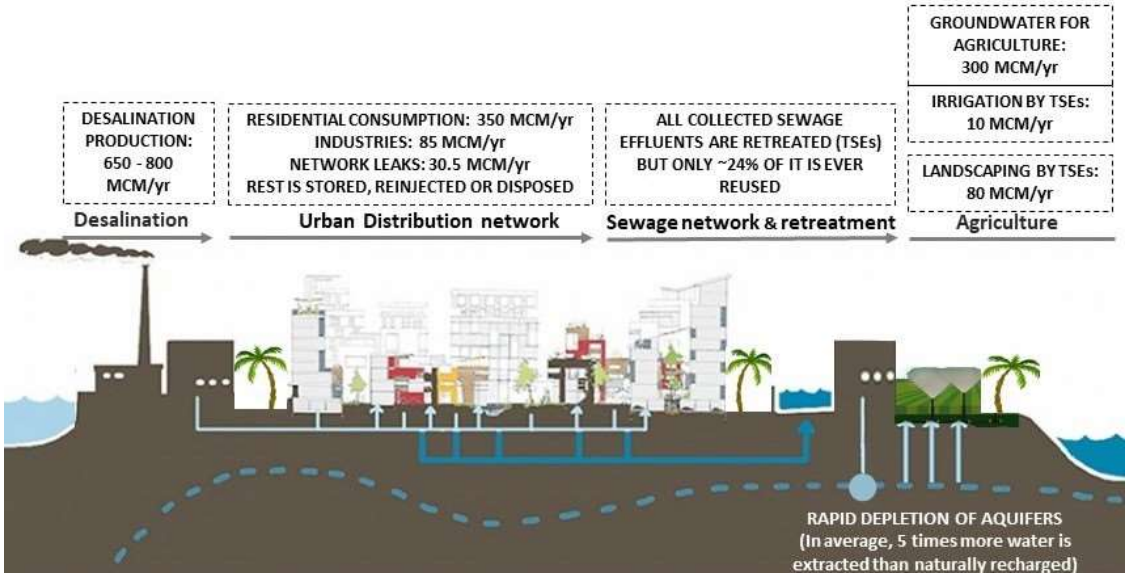

Figure 1. Qatar WEF Nexus infographic.

2. General Context and Theoretical Framework

Qatar is an arid and small peninsula, located just north of the Tropic of Cancer, on the arid to hyper-arid Eastern side of the Arabian Peninsula, in Southwest Asia. Qatar features high summer temperatures with over 40 °C, high evaporation rates, low precipitations and no permanent river body. Average precipitation since 1990 has been of about 92 mm per year. Given the low and unpredictable precipitations, these cannot directly be relied upon for irrigation, though they contribute to the meagre recharge of groundwater resources. In addition, in 2008–2015 the total rainfall was lower than the average rainfall registered in the period 1962–2015, according to the ministry of development planning and statistics [15] (p. 17). Rainfalls are most likely in the period November–May, but they are marked by strong inter-annual variation both in terms of seasonal occurrence and total amount.

As an arid and areic country, Qatar has no surface freshwater resources, and only meagre rainfalls and increasingly depleted groundwater resources: the northern groundwater, the southern groundwater basins, and three minor ones called Abu Samra, Doha (located below the capital city's metropolitan area), and the Aruma deep groundwater basins. The northern groundwater basin is the most important as its quality is suitable for irrigation; it covers almost 20% of the Qatari territory and its depth is between 10 and 40 m below the ground. By contrast, the southern groundwater basin, which extends to about 50% of the territory, has low quality and is therefore not suitable for agricultural uses. The deep groundwater basin has good quality water, but is very deep, over 450 m below the ground, which makes its use a hard and non-economically sound option [16,17]. Qatar is instead renowned worldwide for other underground resources.

Hydrocarbons, Rentier State Theory and the "Generosity" of the State

Located between Saudi Arabia's richest oil region (al-Hasa) and the Persian Gulf's vast offshore reserves of oil and gas, Qatar features significant volumes of oil and the world's fourth largest proven reserves of conventional natural gas. Since not long after World War Two, Qatar has benefitted from increasing revenues of its hydrocarbons exports, which have rapidly transformed the political economy in the region and deeply transformed the state–society relations [18–20]. The various oil and gas booms of the past half century have made a small state like Qatar—along with the likes of Kuwait and the United Arab Emirates—a country that has experienced some of the world's fastest growth in their Human Development Index (HDI) and one of the richest countries in the world in terms of GDP per capita. This transformed State-society relation, marked by a cradle to grave welfare state but

no democracy, has affected all aspects of politics in these countries and made their generous water governance model arguably unique [2].

The political literature on rentierism in the Arab world often explains the absence of democracy in the region by their political economy, and primarily the rentier state paradigm [18–24]. Matsunaga [25] underlined two key features of the rentier state literature that are used to explain this situation: as the rentier state does not need to tax its population—due to sufficient rent revenues—it is consequently under no obligation nor even supposed to be accountable to its citizens [18–24]. In other words, from its fiscal autonomy structurally stems its political autonomy. The second theoretical point is that the rentier state is protected from democratic aspirations from its society because the very generous redistribution policy tends to depoliticize it [18].

After independence (1971) and during the troubled times of the Cold War, highly subsidized or even free water and electricity provision had long served as ways to support a previously poor population and to legitimize the young, small and vulnerable rentier states of the Arabian Peninsula. In line with the literature on rentier state theory (RST), Lambert [2] attributed the water achievements (e.g., universal access to safe, reliable, and particularly affordable freshwater supplies) of the desert petro-monarchies of Abu Dhabi and Kuwait to a centralized form of governance wherein the post-independence regimes generously redistributed some hydrocarbons export revenues—or rent—to its population, through politically charged welfare services and benefits. In Qatar, this involves free water and electricity services for its citizens as well as imported and subsidized food products (via specific shops) in exchange of the population's full support of the monarchical regime. Often summed up by reversing the American revolutionary motto "no representation without taxation", the rentier state literature essentially relies on the idea that the redistribution of the rent revenues and the absence of taxes are trade-offs that enable the authorities to rule without real popular demand for participation. This literature generally concludes that rentier states will not liberalize, nor democratize, as long as their political economy remains characterized by rentierism, unless, argued Luciani [26] (pp. 131–132), a durable budgetary crisis—due to very low rent revenues—forces the state to reform.

But despite budgetary issues, e.g., in the mid-1980s and 1990s or after the 2015 fall in international oil and gas prices, the system of strong subsidies and free services for the Qatari nationals has always remained in place since its establishment, half a century ago. With 100 percent access to a safe water supply and being among the world's top largest water consumption per capita [1], with large footprints of electricity and food consumption per capita, the petro-monarchy of Qatar seems to illustrate perfectly well this idea of a rentier state's sub-optimal governance of resources and services, for political reasons. However, as a consequence, it also seems to illustrate very well the sustainability crisis of the water-energy-food sectors many countries are facing. We argue however, that the water sustainability crisis in Qatar is silent because it does not generate supply disruptions nor any public discontentment, and therefore the citizens in Qatar do not perceive nor experience the depth of the crisis at all. Fuelled by the government oil and gas revenues, free services and subsidized food products maintain high consumption levels of water, energy, and food among Qatari Nationals, even during the current air and sea blockade of the country. Perhaps, some would argue, it is precisely because of the external challenge to the ruling elite that the government maintains its generous welfare services to keep on enjoying a strong popularity among the population.

The blockade of Qatar is a diplomatic crisis that began in June 2017, when a coalition of countries led by Saudi Arabia decided to severe diplomatic relations with Doha. This implied the banning of Qatari airplanes and ships from using the airspace and sea routes of the anti-Qatari coalition countries, mainly Bahrain, Egypt, Saudi Arabia, and the United Arab Emirates. Moreover, Saudi Arabia also closed the only land crossing that Qatar has [10]. The reason behind the blockade was the Saudi claim that Qatar was supporting revolutionary Iran and extremist groups, thereby violating the solidarity rules and principles of the Gulf Cooperation Council (GCC) group of Arabian monarchies. The blockade directly and negatively impacted Qatar's food supplies, most of which is imported and used to come by land from Saudi Arabia, while most of the rest was shipped in from the United

Arab Emirates [27]. In fact, "these routes were immediately cut off when the embargo began and motivated drastic initial responses, including airlifting dairy cattle to replace milk supplies lost when the Saudis closed the border, as well as shipping food from Iran and Turkey" [10] (p. 2). However, the blockading countries represented for Qatar more of a transit territory via which Qatar was importing and exporting products, rather than producing countries. In fact, in 2016 only about 15% of Qatari import originated from those countries. Because of the blockade, Qatar boosted its sea trade to make up for the terminated land trade and particularly increased its trade relations with Iran and Turkey [10,11].

3. Qatar's Silent Water Crisis: A Critical Re-Construction of Qatar's Political Economy of Water

3.1. Qatar's National Water Allocation

The most important factor in the generation of the silent water crisis of Qatar over the past quarter of a century has been its joint economic and population growth. Its rapid economic expansion required foreign labor to come in large numbers and work in all sectors, eventually overwhelming the endogenous population by a factor 9. From 1990 until 2014, annual GDP increased from QR 43,977 million to QR 384,372 million (a rise of 774%) and total population rose from 420,779 to 2,216,180 (an increase of 427%) according to published governmental records [15] (p. 21). At the same time, per capita consumption has been increasing due to the richer lifestyle conducted by large segments of the population of Qatar, and, among the poorer segments, largely due to the heavily subsidized water cost.

This long-term increase in the population has meant a long-term pressure on limited natural resources and an ever-increasing demand for desalinated water. Yet by 2002, rising international oil and gas prices entailed a very strong economic growth for Qatar and other hydrocarbons-exporting countries in the following years, eventually reaching two-digit figures in the case of Qatar and enticing large numbers of foreign workers to these emerging economies. The urgency of Qatar's silent water crisis became a significant concern for the authorities. This situation reached its apex during and following the country's major peak in water demand growth, when the population doubled between 2007 and 2011. The government had then to urgently meet this extra-ordinary demand by at least doubling installed desalination and electricity generation capacity as rapidly as possible, as well as the distribution networks, sewage networks, new retreatment plants, etc. The priority was, as in any other countries, given to fresh water and electricity production and distribution. As a first result, the government of Qatar awarded contracts for water and electricity projects worth USD 8.4bn during 2008 alone, in a country of then only 1 million inhabitants.

This heavy spending on water and electricity co-generation infrastructure (the two are produced in a joint industrial process) lasted for the whole 2008–2018 decade, despite the 2008–2009 economic crisis and the 2014–2015 major fall in oil and gas prices. The government of Qatar spent an average of USD 3bn0 per year on water and electricity projects between January 2008 and May 2018, for a total of USD 31bn (MEED, 2018).

In 2015, 250 to 300 million cubic meters (mcm) of groundwater resources were used by agriculture, 85 mcm of desalinated water by industrial and commercial sectors, and about 350 mcm of the latter by the domestic sector, while about 80 mcm of Treated Sewage Effluents (TSEs) were used by the government sector for landscaping and construction [15] (p. 38). It is important to underline that in the 2006–2014 period, which was characterized by a period of generally high oil and gas prices and economic boom, the quantity of water use increased from about 450 mcm to about 800 mcm, with a strong increase in water use by the governmental sector (essentially for construction projects), which increased by +340%, and the commercial sector, with an increase of about +200%, while the water for irrigation has only slightly increased (+14%) [15] (p. 23). Compared to the previous two sectors, the industrial sector consumes little water, but is marked by a continuous increase in demand: from 2.5 mcm in 2002, to 8.3 mcm in 2006, and to 10.5 mcm in 2014. It uses mainly desalinated water

supplied by Kahramaa (Qatar's sole national water provider), groundwater resources from wells, and some seawater desalinated in private industrial establishments (for which data are not available).

Concerning leakages and water loss—a problem that affects every modern city to some degree—they amount in Qatar to a concerning level of about 25% of the water supply, meaning that a quarter of the water produced is "lost". In parallel, the unaccounted-for water is also over 30%. This situation represents a certain—though not publicly assessed—economic burden on the water utility. Kahramaa, the Qatari water utility, has reduced the water leakages in the past decade, but the problem remains mainly in unaccounted for water. In fact, the "total loss has decreased from 32.0% to 20.9% and real loss from 28.9% to 6.3%. [...] the total system volume input increased from 301.5 million m^3 to 485.4 million m^3. Meanwhile, the real loss in terms of volume slumped from 87.23 million m^3 in 2008 to 30.5 million m^3 in 2014" [15] (p. 25), where real loss is leakages and physical losses, and what is not included is the unaccounted for water, meaning the "unauthorized consumption (theft or illegal use), and all types of inaccuracies associated with production metering and customer metering" [15] (p. 25). Hence, while the total loss has been reduced from 32% to 20.9%, that means that most of the 20.9% is due to unaccounted for water.

Urban water supply in Qatar largely comes from desalination, which increased from 35% of total consumed water in 1990 to 59% in 2014 [15] (p. 22). Almost all the fast-increasing water demand of the past decade, when the population doubled between 2007 and 2011, has been met by increasing desalinated water quantities. This trend has remained since, although at lower pace over the past decade, yet still with a growth of 38% between 2012 and 2017 [28] (p. 48).

Desalination represents now 100% of household water provision in the capital, Doha, and other cities. It is used for both household and industrial consumption, though it is costly and requires abundant and cheap energy supplies, especially natural gas. Consequently, it should be acknowledged that desalination is not a sustainable source of freshwater. In fact, desalination has negative impacts on the environment because of the energy consumed and carbon emitted, the brines produced and chemical discharges, which altogether negatively impact the marine ecosystems and air quality [29] (p. 2316).

Following decades of demographic growth and the increase in desalination capacities and costs, the different governments of the Gulf explored the idea of partially privatizing this activity during the 1990s, which was a period of low oil prices. Qatar and its neighboring countries partly implemented this reform the following decade, paradoxically despite increasing oil and gas revenues [2,30]. However, following the 2014–2015 fall in international oil and gas prices, the fiscal situation of Qatar and similar petromonarchies deteriorated again. For instance, during the first quarter of 2015, Qatar had a first deficit of USD 6 billion. Qatar began tapping into its cash reserves accumulated over the past dozen years, and initiated reforms to at least alleviate the budget deficit. A week after, Qatar's Emir told the Majlis (a local form of partly elected, partly appointed parliament) that the state can no longer "provide for everything"; the Qatari Minister of Development Planning and Statistics declared it "urgent" for the country to seek new revenue sources such as taxes and to better "rationalize" state support programs. Among the austerity measures, various water and electricity subsidy reform policies have aimed to decrease both per capita consumption rates and state expenditures [31].

Qatar's state-owned national water and electricity distribution company, Kahramaa, faces a remarkable challenge: reducing the water demand of households and decreasing the total costs to the government while keeping on providing sufficient and reliable water supplies to consumers. Despite important information and awareness campaigns in many public places, and in spite of increased tariffs since 2016, there remains a long way before consumption patterns in Qatar become close to international averages. It is one of the highest levels per capita in the world, at 557 liters/day/inhabitant [32]. Furthermore, despite tariff increases, interviewed industry officials from the national water provider argue that the current tariffs are still not reflecting the actual production and distribution costs. It is noteworthy that Kahramaa has stopped publishing national consumption statistics which could have provided figures about the post-blockade water balance and national

consumption. However, Kahramaa still publishes other reports, e.g., about infrastructure development, etc., just nothing that documents increase in groundwater mining.

From an economic perspective, recent studies—for instance realized at the World Bank—have highlighted that the issue of water scarcity is basically a problem of misallocation of resources among alternative uses, rather than of physical scarcity, as also emerges for instance in the case of Qatar [1]. While Qatar has been expanding water supply through technical solutions—mainly desalination—from an economic perspective, the cheapest water supply source in Qatar would be from treated wastewater rather than desalination [9,16,29]. On the water demand side, cuts in water allocation would be most effective in the water for gardening and green spaces, in reducing water demand for domestic use, and in water for irrigation. This would include strategies such as increasing water tariffs for domestic and agricultural uses. Those would be the outcomes of economic analysis, nevertheless, as emerges from this paper, considerations of the state-society relationship influence decisions and implementations of the tariffing system for domestic use; while treated wastewater uses are influenced by considerations of cultural norms [32].

3.2. Depleted Groundwater Resources and the Potential of Treated Sewage Effluents

Qatar's silent water crisis is also due to the over-exploitation and depletion of the country's groundwater resources. Given that the groundwater resources are not visible to the general public, due to the nature of this resource, the citizens are not aware of their depletion, making the water crisis more invisible and silent.

After decades of governmental laissez-faire approach, groundwater resources in Qatar are overexploited and several times over-abstracted. While in the 1970s the extraction of groundwater resources equaled the natural replenishment rate [29,33,34], the renewable groundwater resources is estimated at about 58 mcm per year but the total withdrawal was at about 250 mcm in the mid-2010s, i.e., almost five times the replenishment rate. Nonetheless, since 2005 and until recently, abstraction from groundwater aquifers had more or less remained at the same annual level [15] (p. 22). In June 2017, however, following an embargo abruptly imposed on Qatar by several neighboring countries, Doha started a rapid reconfiguration of its food import logistical lines [27]. The government and private sector rapidly launched new initiatives, plans and projects to increase food self-sufficiency levels in a number of niches. One year after the siege, for instance, the press reported that the production of local vegetables had increased from 50,000 tons per year prior the blockade to 65,000 tons per year following the blockade, i.e., an increase of 30% [35], with as of yet unknown quantitative consequences on the groundwater levels. Nevertheless, the government has kept supporting new food production initiatives, with, for instance, the provision by the Ministry of Municipality and the Environment of greenhouses, improved seeds, fertilizers, pesticides, irrigation systems, vaccination and medicines. Additionally, state-owned Hassad Food Company has been providing marketing support to new local products and Kahramaa applies a general tariff rate that is supportive of local productions.

Overused groundwater resources are slowly showing an increase in salinity and a decrease in their quality. This is due to the fall of the water table triggering a saline intrusion (Qatar is a small peninsula), as well as to the brine of farm processes being sometimes improperly discharged. Given the increasing salinity in the groundwater, which is used for irrigation, this has resulted in increasing levels of salinity of the soils, and, prior to the blockade, in farms being sometimes abandoned by farmers [15]. As put by the President of the development planning and statistics authority in 2017, Saleh bin Mohamed al-Nabit, "our fresh groundwater reserves are still being overexploited, which leads to lower groundwater levels and increased salinity" [15] (p. 5). He explained that Qatar instead "relies on seawater desalination as the primary source for drinking water and on groundwater abstraction for agricultural purposes. The reuse of treated wastewater has become an important alternative source of water for agricultural and green spaces irrigation and district cooling" [15] (p. 5). Desalination accounts to about 50% of the general national water supply, but almost 100% of the urban water

provision, if landscaping consumption is set aside. Groundwater provides 36% of the total water supply and treated sewage effluents (TSEs) to about 14% [36].

The Qatari legislation requires all sewage effluents from urbanized areas to be retreated at tertiary level, using in several of the five retreatment plants of the country advanced treatment methods, such as ozone and reverse osmosis (RO). However, only 24% of the end product, TSEs, are actually reused annually, contributing to just 14% of the total water supply [15] (p. 22). The rest is rejected into the Gulf waters, the desert (i.e., the natural landscape) and, for a smaller share, reinjected into aquifers. There is thus a great gap and a great potential for increasing this amount, especially given the strong population growth, which makes this resource grow equally fast. The production cost of TSEs is significantly lower per cubic meter than that of desalinated water (TSEs costs about a fourth of desalinized water in Qatar), but cultural barriers towards TSEs (considered as "impure" by most citizens) still impedes their greater reuse [32]. Lambert and Lee [32] (p. 97) conducted a study to understand the public acceptance of Qataris on the reuse of treated wastewater, finding that Qataris are more likely to accept greywater reuse for outdoors rather than indoor purposes: "very little objection to greywater reuse for landscaping purposes, to a significantly lower acceptation for in-home reuses (e.g., for AC units or toilet flushing)". Research on the reasons behind these public opinion perception points to opposition based on health risk, psychological repugnance, and religious beliefs. Scholars have also found that attitudes are often directly linked to the level of education and age of the respondents [37]. While it has been argued that religious and cultural norms may have contributed to the public perception of treated wastewater being "dirty", in the past decade ministries of water and water practitioners across the Middle East have been working with religious leaders to try to shape and redirect these cultural and religious norms, underlining that treated wastewater can be reused, especially for outdoor purposes.

Because of a lack of demand for this specific resource, the country does not have yet all the necessary infrastructure to redistribute a greater share of this water where it is needed for some specific usages, such as landscaping or construction. Currently, almost only trucks, most of them held by private companies hired by the government, deliver TSEs where it can be reused, generally by another government entity. As it is negatively perceived by the population, as in all other Gulf monarchies [38], its use has been essentially restricted to landscaping, and more marginal uses. As noted by Darwish [9] (p. 1255) in 2005, 80% of TSEs was used for irrigating green areas in the capital and, to a lesser extent, by farms for growing fodder. The other diverse minor water uses are, e.g., for district cooling in some neighborhoods and the making of cement in some construction projects. Although they have kept on gaining importance in terms of relative demand over the past years, there is still no strong market for TSEs because of the logistical and economic difficulties associated with this resource due to the lack of network infrastructure.

While water consumption had kept growing at a fast pace for years, the sewage network and retreatment plants were seen as secondary priorities by the government. A sewage effluent crisis happened by 2008 and culminated in 2009 when the banks of an artificial lagoon filled with raw sewage effluents of new neighbourhoods were at risk of collapsing, local civil servants explained. The Abu Nakhla lagoon had been filled on a daily basis by sewage trucks and it rapidly grew to dangerous proportions, at an average discharge rate of approximately 50,000 m^3 d^{-1} to 100,000 m^3 d^{-1}, with only an estimated infiltration and evaporation rate of 50,000 m^3 (Tollenaere, 2015:4). Discussions with civil servants from Ashghal (the public works authority) and Qatar Ministry of Municipalities and the Environment revealed that during the late 2000s, the authorities had to manage the risk of collapse of the Abu Nakhla lagoon and the risk of contamination of underground water resources below it and below the Karana lagoons, which was also made of raw sewage effluents as well as industrial wastewater. At the same time, the country also had to develop in emergency its basic sewage collection network, urban development, and drainage system. At that time of raw sewage effluent crisis and fast increasing freshwater demand, a redistribution network for the treated sewage effluents was clearly not a high priority. This unfortunately led to the present situation wherein the sewage effluents are now fully retreated and TSEs are available in large quantities but largely unused (at 76%, according

to governmental statistics), essentially due to a lack of distribution infrastructure. The government understood this issue by the early 2010s but the National TSE master plan has suffered a major setback having been released not long after the 2014–2015 fall in international oil and gas prices, which has severely affected the country's finances. The subsequent cut in general expenditure for infrastructure projects has made that strategy, and particularly its timeline, significantly off track for the time being, despite the recent completion of some long overdue projects South of the capital. Since the 2015 fall in international energy prices and particularly since the subsequent dramatic fall in oil and gas prices in early 2020, lower levels of government revenues have incapacitated the relevant authorities to rapidly reverse this long-established situation. The target of a 100% TSE reuse before hosting the 2022 World Cup in Doha does not seem particularly feasible now, all things being equal. Furthermore, due to geopolitical tensions growing and eventually leading to a blockade of the country in 2017, the government invested in desalinated water security infrastructure, rather than in TSE water reuse. By the mid-2010s, Qatar endeavored to improve its water security via massive infrastructure projects to increase desalinated water storage and management capacities. Kahramaa eventually opened in 2018 the world's largest potable water mega-reservoir, as part of a project of 15 concrete reservoirs, situated at five sites, connected to the country's main desalination plants and each holding up to 100 million gallons. The USD 4 billion investment has been designed to ensure seven days of reserve supply, by contrast to the meager two days of reserves before, which were not enough to evacuate the whole country in case of desalination plants being made out of service by, e.g., a large oil spill, military strikes or large-scale algae bloom. The government already envisions expansion plans that should increase capacity to 40 reservoirs, holding a total of 4 billion gallons, for around three weeks of reserve supply. With this example of large-scale infrastructure development, it appears the main barrier to meaningful reforms of the sector towards a more efficient and sustainable water sector is more due to a fundamental governance issue, rather than a lack of economic means, and not the least the politically-charged and unlimited provision of desalinated freshwater and electricity at subsidized rates and the absence of water and electricity bills for large segments of the society.

4. An Inside Eye on Water and Electricity Bills in Qatar

This section analyses to what extent can Kahramaa, the national water and electricity distribution company, contribute to shape consumers' demand in order to reduce the national water and energy demand, to ensure a more sustainable use of those resources. Nevertheless, we must note that following Kahneman's pioneering works, behavioralists would argue that pricing is just one element influencing behaviors, alongside social norms, social psychology, default modes, etc. If Kahramaa assumes that increases in prices will help reduce per capita consumption, it is important to assess how many consumers in Qatar ever pays a bill, and how many even receive a bill at all. Qatari citizens constitute a demographic minority in their own country as the majority of inhabitants is made of foreign workers, at around 90%. The latter are mostly blue-collar workers working essentially in the construction sector. They generally live in workers dormitories and do not pay any utility bill, which is collectively paid by their employer. The foreign white-collar workers, however, generally live in the country with their nuclear family in family accommodations and are supposed to pay for their water consumption, although some of them live all year long in hotels and never receive a utility bill, while for some others, their employer may pay for it as part of their expatriation package. On the other hand, the Qatari government fully subsidizes water for the Qatari nationals' main residence, while the national legislation completely outlaws the ownership of a land or accommodation in Qatar by a foreigner, except in a few special zones. Consequently, as Lambert and Lee [32] noted, most of those who own their accommodation (i.e., Qatari nationals), do not pay water bills, while the ones who have to pay a utility bill are those who do not own their housing and who stay only some years in the country (i.e., most foreign residents). There is thus overall a limited economic case for household investments in efficient residential water and electricity appliances.

In autumn 2015, researchers at Qatar University decided to investigate the issue of water and electricity billing. They implemented a nationally representative phone survey of adult Qataris (n = 742) and adult white-collar expatriate workers (n = 742). Those who live in workers dormitories, i.e., blue-collar workers, were not surveyed, as they never have to pay for such a utility bill, as explained above. The study found that the majority of adults (42%) in Qatar who use municipal water in their private accommodation never received any bills from Kahramaa. The study showed that only 8% of Qatari citizens and 51% of foreign expatriates actually ever received a bill. Among the latter group, only 45% pay their own bill, while for over half of them, it is paid by others, most often the employer. For 24% of expatriates, water and electricity is included in rent and for 24%, it is directly paid by the employer or local sponsor. Aware of this low level of consumers ever receiving a water and electricity bill, the national provider exceptionally deployed between 2016 and 2018 an additional 17,000 water meters and 17,000 electricity smart meters. Although this shows an interest in addressing this unsustainable situation, this figure needs to be put in perspective. As of 2015 (the latest year of national census data), Qatar already hosted over 201,432 households. In other words, if taking into consideration the growth in population over the past 5 years (+16%) to estimate the number of households in 2020, at around 233,661 households, Kahramaa's newly installed devices are unlikely to monitor and bill more than 7.3% of all households and thus the fundamental issue structurally remains the same. Most people living in Qatar do not pay any water and electricity bills, including blue-collar workers and over half of the wealthier population group: Qatari Nationals and white-collar expatriates altogether. Additionally, over half of the latter two sub-groups cannot receive any bills due to limited metering capacities and a rentier governance that make metering economically irrelevant to this day in most cases.

However, to assess the potential of Kahramaa to decreasing per capita consumption, our survey included questions to evaluate respondents' attitudes and potential behavior adjustments to hypothetical increases in electricity bills. When asked about the extent to which they would reduce their household use of air conditioning (AC) to save money if electricity bills were increased, around 59% of Qataris said they would reduce it "a lot" or "somewhat", as opposed to 70% of high-income expatriates. Similarly, Qataris are more than twice as likely to say that they would not reduce consumption at all (24%) relative to white-collar expatriates (11%). Within the two population groups, the survey indicates that willingness to reduce air condition consumption differs according to gender, as willingness to reduce consumption was on average around 10 points higher for women in both population groups. Moreover, among high-income expatriates, respondents from Asia (73%) and the Middle East and North Africa region (70%) express significantly more willingness than Westerners (59%) to reduce their AC consumption in the event of price increases. The willingness to reduce AC consumption does not differ according to education level. To consider the context through which Kahramaa operates, the extent to which households receive bills and the potential influence of receiving bills on electricity consumption is analyzed. The results reveal that the majority of households in Qatar do not receive any electricity bills, with only around 42% of respondents receive an electricity bill. It also reveals that there is an important difference among the two population groups regarding the proportion of households that do receive a bill: around half the expatriates receive a bill, whereas 8% of Qataris do. This finding is notable because paying one's own electricity bill was found to have a significant impact on willingness to reduce AC use, which is the main source of domestic electricity consumption in Qatar. Among expatriates who pay their own bill, there is around twice as much willingness to reduce AC use if bills increase relative to expatriates who do not pay their own bill. Specifically, 33% of expatriates who pay their own bill would be willing to reduce air condition consumption "a lot" or "somewhat" in an increased price scenario, as opposed to around 18% for those that electricity is included in rent or whose employer pays the bill. From recent interviews, these trends have been confirmed also after the blockade of Qatar.

5. Qatar's Unsustainable Food Security

Qatar's rapid increase in population, similar to other countries in the region, has meant a fast increase in total food demand ever since it became an oil exporting country. In addition, similarly to the growing amount of water per capita in the past years, the new lifestyle and improved standard of living have resulted in an increase in food demand per capita. The main limiting factor of the agricultural sector in Qatar remains thus water: the lack of renewable freshwater resources and decreasing groundwater reserves, the high production costs of desalinated water, and the Qatari population's general opposition to the use of retreated waters, particularly of Treated Sewage Effluents [32,39].

Food security, as defined by the Food and Agricultural Organization [40], occurs "when all people, at all times, have physical, social, economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life". As such, Qatar's oil and gas wealth has enabled it to have a high level of food security by massive imports of food from the international market. Around 90% of the food consumed in the country is imported in Qatar [41]. Qatar re-considered and revamped its food security policy options in an unusual way to ensure food security following the 2008 global food crisis [42,43] and the 2017 land blockade and maritime embargo of food products by its Arabian neighbors due to an ongoing diplomatic crisis [27].

Following the 2008 international food price crisis, Qatar established the Qatar National Food Security Program to reduce the country's vulnerability regarding food imports through higher self-sufficiency, emergency plans and better institutional arrangements for food imports. However, the vulnerability to external market is not only economic—i.e., the general variability of, and ad hoc hikes in, food prices—but also geopolitical, as certain countries may choose to change their export policies or even boycott exports towards Qatar. The blockade that started in June 2017 has been seen in Doha as a wakeup call to Qatar and to all Gulf monarchies, as they are all heavily relying on food import. As Irani [44] (p. 1) puts it, "the GCC crisis has demonstrated the power of food supplies as a political tool in the region." Hodgson [45] shed light on this point and stated that at the beginning of the crisis, when most food had then to be airlifted towards Qatar, that "although alternative trade arrangements have been made with Turkey and Iran, [...] Qatar is now paying ten times more to import food and medicine than before sanctions were imposed" [45] (p. 1).

A possibility that has been explored by several oil rich countries—such as the United Arab Emirates and Saudi Arabia—as well as by China, is buying land in developing countries, especially in the Nile Basin, to cultivate food and ensure food security for their country [42,43]. According to Keulertz [42], this opportunity has also been explored by Qatar for the case of Sudan, but it never materialized. Keulertz discusses [46] (ch. 5) land investments in several countries, focusing in particular into a failed land investment by Qatar in Sudan. Building on this, Keulertz investigates the domestic politics about land investments in Qatar, showing the power struggles, the role of shadow states, and the politics around land investments to increase groups' interests and influences in the Gulf country.

On the domestic side, nevertheless, the Qatar National Food Security Program established the goal to produce 40% of its total food needs by 2025. Nevertheless, Qatar's National Food Security strategy—which expressed a vision for food security in the country—was never adopted (it never became a formal policy) and has been updated with a new food security strategy in 2019. Nevertheless, this strategy has gained momentum since the 2017 blockade. In fact, in April 2018, less than a year after the blockade, the Qatari Ministry of Municipality and Environment announced that "Qatar had achieved 98, 86 and 82 percent self-sufficiency, respectively, in fresh chicken, dates, and poultry products. Further, the ministry expects Qatar to be 70, 90, and 100 percent self-sufficient in fresh vegetables, table eggs, and fish and shrimps, respectively, within the next two years." [46] (p. 7). Self-sufficiency levels in fresh chicken, milk, and dairy products were eventually reached in 2019 [35].

Afraid of potential disruptions of Qatar's ever increasing food supplies amidst a turbulent region, the then Emir of the country, Sheikh Hamad Al-Thani, ordered by Emiri Decree No 45 of 2011 the creation of the Qatar National Food Security Program to further research the matter and work with national and foreign stakeholders to develop an "integrated national food security plan". In 2014,

it submitted its finalized comprehensive National Plan that had then to be implemented by the Ministry of Economy. It first and foremost directed developments to the domestic agricultural sector, national supply chains (e.g., the country had no deep-water port), and better food processing. It also put sustainable use of water, land and energy resources to the forefront. Taking into consideration the climate conditions of the country and its limited freshwater resources, the National Plan put forward new standards and a roadmap for crop selection and suggesting best practices from other countries. The main measures contained in the National Food Security Program to achieve the objectives of the program involve four sectors: agriculture, water, energy, and food manufacturing. Concerning agriculture, the program envisions the introduction of best practices and a farming business model, based on economic efficiency and on optimal use of scarce resources principles. The program emphasizes the central role that technology would have in saving water and making its use more efficient in irrigation. The use of greenhouses and hydroponics is also supported as a viable solution. At the same time, measures and mechanisms to protect the market will be introduced, including subsidies and price support mechanisms. On the water side, desalination is still seen as the main water source, and use of groundwater resources, which are currently over-exploited, is discouraged. Concerning the energy sector, the program's vision is to increase the reliance on renewable energies, especially on solar and wind power, while adopting a smart grid to enable the integration of different electricity sources. The food manufacturing sector would facilitate achieving the goals of the program by reducing food wastage and enhancing storage potential, supporting and expanding the food processing industry in the country. The end goal was to make Qatar's agriculture sector radically more efficient in order to produce five times more food with the same amount of land and one-third less water than was used then [47].

However, these bold water saving targets of the National Plan were never reached. Annual irrigation water extraction from aquifers has overall remained at the same level since 2014, in average close to five times higher than the cumulated rainfall regeneration rate and slowly growing artificial aquifer recharge with TSEs [48] (p. 22). Concerning food processing, government officials have been studying the issue of regulations for food processing and labelling, in order to reduce food waste and increase food security. Yet, a decade after the 2008 global food price crisis, observers could still argue that much could be improved for food processing and food mentality in Qatar [49] (p. 1):

> "Current legislation tends to encourage rather than limit food waste—and this needs to be reversed. Qatar has a system of strict expiry dates, with no "best before". This affects consumer attitudes and, in a more major way, that of retailers. Any expired products are often sent to landfill as this is cheaper than returning them to distant manufacturers. Smart marketing and widespread education are needed to change "normal behaviour" among consumers who currently reject "non-perfect" foods, see excess food as rubbish, and prefer luxury global brands as a definition of status. A culture of good hospitality and buffets for every social occasion and event isn't helping the food waste problem. In particular, Qataris will need to learn to accept the lower standard (at least initially) of food produced locally by an immature industry but one with much potential for enhancement."

This focus on supply-side policies for food during the case of a blockade, which thus requires a supply-side and non-sustainable water resources management, at least for a time, has been well captured by the directives the former Head of the Qatar National Food Security Program had received from the country's highest authorities at the beginning of his mandate. Interviewee Ambassador Fahad Al-Attiyah explained that he had received the explicit directive from the country's Emir a decade ago that a contingency plan should be made ready and that it should be able to make everything available in case of major disruption. "Even berries", he recalled, visibly still impressed by the daunting challenge they had to face.

Today, about a third of the total water consumed in Qatar goes to agriculture, producing mainly vegetables and fruits, but also dairy products, poultry, and processed food, inter alia. However, the contribution of the agricultural sector to the GDP in Qatar remains in average of only of 0.1% (despite

a post-blockade peak at almost 0.2% during the first term of 2019), and employing less than 1% of the population, the vast majority of whom are foreign workers [27]. Such a massive allocation of limited (and fast depleting) freshwater resources to a sector generating so little economic benefits and so much utility costs says a lot about the presently un-sustainable condition of Qatar's food security and water-energy-food sectors.

What emerges is that there is little to no medium to long-term coherence between the food security and the water security visions of the country. In fact, the dramatic consequences on water resources of the blockade-induced food policy seem to be neglected. It seems that, at least in some niches, like fresh vegetables and poultry products, Qatar is interpreting "food security" as a synonym of "food self-sufficiency". This contrasts with the concept of "virtual water trade", which was elaborated precisely by looking at the situation in the Middle East by Prof. Tony Allan. Virtual water is the amount of water embedded in goods or services. For Allan water-scarce countries and regions like the Middle East have been able to ensure water security through large quantities of food imports in grain, livestock etc. For this reason, the region met the water balance—not thanks to its own scarce water resources, but by purchasing and importing water already embedded in agricultural products. A recent study by UN-FAO about water scarcity initiatives in the Middle East considered the economic efficiency of specific crop productions in the region, when the "shadow cost of water" is properly taken into account. The conclusions are that importing most agricultural goods, even after accounting for a myriad of possible trade friction costs, are—to a very large extent—much more efficient than domestic production. On a purely economic level, self-sufficiency represents a sub-optimal use of resources, including water and energy, especially for water scarce regions and dry lands like Qatar. The agricultural sector in the Middle East plays an important role in the rural development, and in maintaining rural, cultural, and historical traditions. Therefore, what is needed in water-scarce countries is a reconsideration of the agricultural sector and on strategies to achieve food security, strategies that need to be harmonized with the water sector vision, as well as in consideration of rural development and the agro-ecological system.

As seen above, most water consumed in Qatar is imported, making Qatar a net virtual water importing country. As noted by Sayeed and Darwish [50] (p. 122) "the total virtual water flow was 24,470 Mm^3 for the period 1998–2015, with an average virtual water flow of 1350 Mm^3/y. The total virtual water flow into Qatar increased from 500 Mm^3 in 1998 to 2147 Mm^3 in 2015".

The silent water crisis, particularly, could easily be read between the lines of the cautious words of the President of the Planning and Statistics Authority of Qatar. Amidst new heights of natural gas exports, and despite a continuous increase in desalination capacities and in reinjection of retreated water into the aquifers, the preface of Qatar's third and last Water Statistics Report, written in December 2018, does not bode so well for the sustainability and medium- to long-term perspective of Qatar's water and food security in the current paradigm [48] (p. 5).

> "Our fresh groundwater reserves are still being overexploited, which leads to lower groundwater levels and increased salinity. This in turn makes it difficult to use the groundwater for irrigation and drinking water purposes in the future."

6. Conclusions

This article investigated how the rentier nature of the state policies on water have affected the Qatari water, energy, and food sectors over the past decades, leading to their current condition of dangerous unsustainability that has reached the proportions of a sectoral crisis—albeit a silent one. It contextualized Qatar's water sustainability crisis in the broader geopolitical context of its embargo, showing the dire necessity of considering national water, energy, food, and trade policies with geopolitical considerations. It highlighted the necessity to rapidly reassess water scarcity outside of the water box, as in Qatar particularly, and in the desert Gulf countries more generally, the interactions between the water, energy, and food sectors—the so-called nexus—are clearer and more tightly intertwined than in many other countries and world regions. To solve the water crisis, it is necessary

to look outside of the water silo, as the three sectors are inextricably inter-linked and inter-connected, and actions in one sector will have impacts on another one or on the other two. The management and governance of these three sectors should thus be integrated rather than considered in isolation and narrowly. Additionally, this deeply integrated paradigm should not be considered uncritically, through a purely technocratic angle, but by investigating the political relations behind and around it, and particularly the rentier nature of the state-society relationship as well as contextualized in the broader political and geopolitical contexts.

In this context, one might wonder why the seemingly enlightened goals for more efficiency and sustainability in water use, initially provisioned for in the national food security strategy, have not yet been implemented in Qatar. Over 50% of the water annually used in the country is desalinated water, produced thanks to the large reserves of natural gas that Qatar has. Desalination is an expensive and energy-intensive process, which Qatar has been using in the past decades to meet the growing demand of a growing population with increasing lifestyle standards and high water and electricity consumption levels. At the same time, all groundwater resources in the country are over-exploited over their safe yield by about five times, reducing the quality of these groundwater, as well as their quantity. They remained yet heavily utilized for food production, with levels of self-sufficiency for some vegetables. Qatar is planning to increase the share of food being produced in the country from 10 to 40 per cent by 2025. This is also accompanied by an increase—albeit slow—in the use of some treated wastewater, especially for irrigation of forage crops. However, almost 90% of the total food consumed in the country is still being imported from abroad.

This study showed the difficult situation that Qatar is facing, as it aims at shifting towards more efficiency in water use, for instance by increasing water tariffing and increasing the reuse of treated wastewater. These aims are, however, continuously challenged by two other aspects that are also priorities for the government: ensuring food security, interpreted especially since the blockade as increasing national self-sufficiency levels for specific food products; and by the generous rentier nature of the state-society relationship, where subsidized water is one of the underpinning and core elements. Hence, Qatar is challenged to increase its efficiency in water use as it is conflicting with other top priorities and agendas of the country. This shows the necessity and importance of coherent strategies and visions across sectors, as it is the only way to obtain synergetic alignment between otherwise conflicting water, energy and food security policies. As climate change renders agriculture ever more difficult amid Qatar's already hot climate and across the sub-region, and as diplomatic negotiations might enable a thaw in ties between Doha and its neighbors, the authors are expecting—and calling for—a more sustainable approach to food security and the Water-Energy-Food nexus overall. After all, even if environmental concerns were not to be considered as a sufficient priority, a more integrated and synergetic approach is most likely to represent good economic reforms, something the authorities might pay particular attention to during this period of particularly low oil and gas international prices and government revenues.

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