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FAILING FLOWS

WATER MANAGEMENT IN SOUTHERN IRAQ

Azhar Al-Rubaie
Michael Mason
Zainab Mehdi

LSE Middle East Centre Paper Series | 52 | July 2021

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Failing Flows: Water Management in Southern Iraq

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About the Authors

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Abstract

This policy brief examines the public water infrastructure in Basra Governorate, southern Iraq. Crucial to the delivery of water services to the population, the long-term deterioration of this infrastructure is a result of armed conflict, international sanctions and defective governance. Water infrastructure upgrading was a priority for state-rebuilding after the 2003 invasion but receded under the civil war. Governmental and donor plans for mega infrastructure water projects have stalled in the face of systemic corruption. Compact water treatment units are the dominant treatment technology, supplying 83 percent of treatment capacity across Basra Governorate and 92 percent in Basra city. The efficiency of water treatment plants supplying Basra city is restricted by the high salt content of water from the Shatt al-Arab and irregular flows from the Badaʿa Canal. Supply flows are impacted by upstream dam construction, climatic variability, pollution and illegal water tapping. In the face of high population growth in southern Iraq, there is a pressing policy need to diversify water sources for Basra and improve the efficiencies of treatment technologies and distribution networks.

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CONFLICT RESEARCH PROGRAMME

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The Middle East Centre is leading the research on drivers of conflict in Iraq and the wider Middle East. Our partners in Iraq are the Institute of Regional and International Studies at the American University of Iraq, Sulaimani, as well as Al-Bayan Center for Planning and Studies, Al-Amal Association, Public Aid Organisation and Iraqi Women Network in Baghdad.

For more information about the Centre's work on the CRP, please contact Taif Alkhudary (t.alkhudary@lse.ac.uk).

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Executive Summary

In July 2018 massive protests erupted in Basra city as residents demanded improvements in public services. Failings in water management were at the heart of local grievances: an outbreak of water-related illnesses was triggered by the increased use of polluted water from the Shatt al-Arab, Basra's traditional source of water. However, the deterioration of public water infrastructure has its roots in decades of armed conflict and international sanctions. Tap water has been undrinkable since the 1990s, forcing most households to rely on private water vendors. Water infrastructure upgrading was a priority for state rebuilding after 2003 but receded under the sectarian civil war. Governmental and donor plans for mega infrastructure water projects have stalled in the face of systemic corruption and racketeering. Compact water treatment units (CWTUs) are the dominant purification technology, supplying 83 percent of treatment capacity across Basra Governorate and 92% in Basra city. The efficiency of CWTUs supplying Basra city is reduced by irregular flows from the Bada'a Canal to the key conduit of the R-Zero water treatment plant. These flows are impacted by upstream dam construction, climatic variability and illegal water tapping. The operational capacity of CWTUs is also limited by underinvestment in their maintenance, often reducing their working life to 10–15 years. There is a pressing policy need to diversify water sources for Basra and improve the efficiencies of treatment technologies and distribution networks.

Executive Summary

في يوليو/تموز عام 2018، إندلعت تظاهرات كبيرة في مدينة البصرة (جنوب العراق) للمطالبة بتحسين الخدمات العامة. الإخفاق في إدارة المياه كان في صميم الشكاوى المحلية: تفشي الأمراض المرتبطة بالمياه بسبب استخدام المياه الملوثة من شط العرب، مصدرالمياه التقليدي في البصرة. ومع ذلك فإن تدهور البنية التحتية العامة للمياه ترجع جذوره إلى عقود من النزاعات والعقوبات الدوليّة. لم تعد مياه الصنبور صالحة للشرب منذ تسعينيات القران الماضي، مما أجبر الناس على الاعتماد على بائعي المياه من القطاع الخاص. تحسين البنية التحتية للمياه كان من بين أولويات إعادة بناء الدولة بعد عام 2003، ولكنه تراجع بعد الحرب الأهلية الطائفية. توقفت خطط الحكومة والجهات المانحة لمشاريع المياه ذات البنى التحتية الضخمة في ظل مواجهة الفساد والابتزاز المالي. لا تزال وحدات معالجة المياه المدمجة (CWTUs) التقنية السائدة لتنقية المياه، وتوفر 83% من سعة معالجة المياه في محافظة البصرة و92% في مركز المحافظة. إن كفاءة وحدات معالجة المياه المدمجة التي تزود مدينة البصرة مقيدة بالتدفقات غير المنتظمة من قناة البدعة إلى الأنبوب الرئيسي لمحطة معالجة المياه R-Zero. وتتأثر هذه التدفقات ببناء السدود عند المنبع وبتقلبات المناخ وباستغلال المياه غير المشروع. تتقيد القدرة التشغيلية لوحدات معالجة المياه نتيجة نقص الاستثمار في صيانتها، وغالباً ما يؤدي ذلك إلى انخفاض العمر التشغيلي للوحدات من 15-10عاماً. هناك حاجة مُلحة لإيجاد سياسة من أجل إيجاد مصادر متنوعة للمياه في البصرة وتحسين كفاءات تقنية المعالجة وشبكات توزيع المياه.

Recommendations for Improving Basra's Public Water Supply

Regional Level

1. *Diversify primary sources of public water.* A sustainable public water infrastructure in Basra Governorate requires the diversification of water supply sources to create system-wide robustness against negative long-term trends in surface water availability (e.g. from upstream damming and projected climate change impacts) and disruptive short-term events (e.g. pumping failures or flooding). Construction of a planned desalination plant at Al Faw would create a major supply asset in the regional public water infrastructure, but this could also generate a single-source dependency without investments in the wider network of water supply and treatment. These additional measures include timely completion of the donor-funded Great Basra Water Project, increased storage (back-up) capacity of the Badaʿa Canal and upgrades in the operational efficiencies of compact water treatment units (CWTUs)—the major purification technology in the governorate (see Section 3 and Section 4).

2. *Improve the operational performance of water distribution networks.* The 240-kilometre Badaʿa Canal is a key artery supplying water to treatment plants in and around Basra city. However, the open character of the canal leads to major flow reductions as a result of evaporation, illegal tapping and the uncontrolled growth of aquatic plants. The project to convert the Badaʿa Canal to a closed pipeline, announced in 2020 by the Government of Iraq, represents an essential improvement to the public water supply infrastructure. While piped distribution to households has high spatial coverage in Basra city (reaching 95 percent of the population of 1.38 million), most of the network is over 50 years old and poorly maintained. Upgrades should be informed by a system-wide risk assessment (see Section 2 and Section 4).

3. *Increase use of wastewater recycling for industrial, agricultural and household use.* In Basra's large oil fields, the extensive use of water injection for oil extraction is unsustainable and highly polluting: there is scope for far greater use of water recycling. Biological treatment of sewage wastewater has significant potential for supporting agriculture in the water-stressed horticultural areas. Other ecological treatment technologies can recycle wastewater for domestic as well as agricultural purposes, contributing also to the long-term restoration and sustainable management of marshland environments (see Section 4).

National Level

4. *Conduct an independent review of water governance in Basra Governorate.* There is extensive illegal extraction from public water networks, which increases operation and maintenance costs and reduces water pressure. Largely unchecked, this illegal tapping extends from individual households to businesses and large horticultural enterprises: it compounds risks to public health from water contamination. There are also multiple allegations of corruption and racketeering associated with water project investments and the maintenance of public water infrastructure. An independent review of public water management in Basra Governorate is needed to determine key challenges and to offer governance recommendations on the basis of inclusive dialogue with affected communities (see Section 2 and Section 4).

Figure 1: Illegal water tapping, Yaseen Khuraibet district in Basra city

Photo: Azhar Al-Rubaie

1. Introduction: The Water Crisis in Basra Governorate

In July 2018 massive protests erupted in Basra city as residents demanded improvements in public services. Throughout the summer, protestors clashed with security forces and armed militia groups, who killed at least 15 protestors and injured 190. The victims were named 'water martyrs' (*shuhada' almiah*) as failings in water management were at the heart of local grievances. An outbreak of water-related illnesses was triggered by the increased use of polluted water from the Shatt al-Arab to offset reduced flows from the Badaʿa Canal. By November 2018, approximately 118,000 people had attended the city's hospitals suffering from serious gastrointestinal complaints. Public health experts attributed these symptoms to poor water quality.[1] The Shatt al-Arab supplies 60 percent of the water treated in Basra Governorate, with the rest supplied by cleaner flows from the Badaʿa Canal. During supply emergencies, extra water is extracted from the Shatt al-Arab as part of a rationing system (*marashanah*) that compensates for shortfalls from the Canal.[2] The Shatt al-Arab is the confluence of the Euphrates and Tigris rivers, yet its flows have dropped considerably since the 1970s because of upstream dam construction in Turkey, Iran and Syria. Reduced freshwater outflow from the Shatt al-Arab into the Persian Gulf is a major contributor to the growing salinisation of the river (heightened in the summer). It is also heavily contaminated by untreated sewage, industrial waste, oil spills and irrigation return flows.[3] Public water withdrawals from the Shatt al-Arab for household use in Basra are directly linked to unsafe water quality levels recorded in 2018.

However, the deterioration of public water supplies in Basra Governorate has its roots in decades of armed conflict, underinvestment and dysfunctional governance.[4] Tap water has been undrinkable since the 1990s forcing households to buy from private water vendors. Water infrastructure upgrading was a priority for state rebuilding after 2003 but Iraqi government efforts receded under the sectarian civil war (2006–2008) and war with Daesh (2013–2017). More recently, governmental plans for large-scale water supply projects, supported by international donors, have stalled in the face of bureaucratic delays and systemic corruption. This policy brief focuses on events since 2018, informed by data supplied by the Basra Water Directorate and 13 local interviews — conducted in August

[1] 'Basra is Thirsty: Iraq's Failure to Manage the Water Crisis', *Human Rights Watch* (2019), p.1. Available at https://www.hrw.org/report/2019/07/22/basra-thirsty/iraqs-failure-manage-water-crisis (accessed 15 February 2021).

[2] Hassan Khleel H. Al-Mahmod, 'Water Resources in Basra and its Recent Problems' [almwaryd almiyah fi albasra wa mushkilatuha alem'easerh], *Marine Sciences Centre, University of Basra* (Basra, 2019), p. 93.

[3] Ameen Kadhim, Ashton Shortridge and Ali K. Al-Nasrawi, 'Cases and Consequences of Environmental Degradation Along the Shatt Al-Arab River: A Coupled Human and Natural Systems (CHANS) Perspective', *GeoJournal* 158 (2020), DOI: https://doi.org/10.1007/s10708-020-10225-0; Wim Zwijnenburg, 'Troubled Waters: Documenting Pollution of Iraq's Shatt Al-Arab River', *Bellingcat* (2020). Available at https://www.bellingcat.com/resources/2020/11/10/troubled-waters-documenting-pollution-of-iraqs-shatt-al-arab-river/ (accessed 11 February 2021).

[4] Mark Zeitoun, Heather Elaydi, Jean-Philippe Dross, Michael Talhami, Evaristo de Pinho-Oliveira and Javier Cordoba, 'Urban Warfare Ecology: A Study of Water Supply in Basrah', *International Journal of Urban and Regional Research* 41/6 (2017), pp. 904–25, DOI: https://doi.org/10.1111/1468-2427.12546.

2020 and October 2020–January 2021 — with water managers/engineers, environmental experts, civil society activists, governmental actors and religious figures. We first outline the current reliance of Basra's public water network on flows from the Shatt al-Arab and Badaʿa Canal. Then, we address the dominant water purification technology employed in the governorate — compact water treatment units (CWTUs). With their modular design, compact units can enhance the system-wide resilience of water infrastructure, but their contribution is limited by the variable quality of raw water and degraded distribution networks which are subject also to illegal water tapping. We caution against relying on mega infrastructure projects, such as seawater desalination, as a one-shot solution to Basra's water crisis, calling instead for a move to *system-wide resilience* through supply diversification, multidirectional connectivity and effective governance.

2. A Vulnerable Water Network

Public water supply reaches 85 percent of the Basra Governorate population of 3.14 million and 95 percent of the city population of 1.38 million.[5] Most of the transmission and distribution pipes were installed in the 1980s, with an estimated total length of 10,500 km.[6] According to the Ministry of Water Resources — which has responsibility for the supply of 'raw' water to treatment plants — the biggest issue with the ongoing water crisis is not the scarcity of water, but rather the existence of old and degraded water distribution networks, subject to extensive damage from illegal water tapping.[7] However, there are major water supply issues in Basra Governorate arising from its downstream location in the Euphrates-Tigris river system. Since the 1950s, the natural flow regimes of the two rivers have dramatically reduced due to upstream dam development for hydropower and irrigation purposes.[8] Water quality has also deteriorated significantly downstream because of large amounts of urban, industrial and agricultural waste pouring into both rivers. The river system feeds into the Shatt al-Arab, which also receives water from the Garmat Ali (a waterway fed by the al-Hammar marshes) as well as from the Karkheh and Karun Rivers in Iran. Iraqi drainage of the al-Hammar marshes and Iranian withdrawals from the Karun River greatly increase the salinity of Shatt al-Arab water as seawater intrudes upstream.[9]

[5] Data supplied by Basra Water Directorate, February 2021.

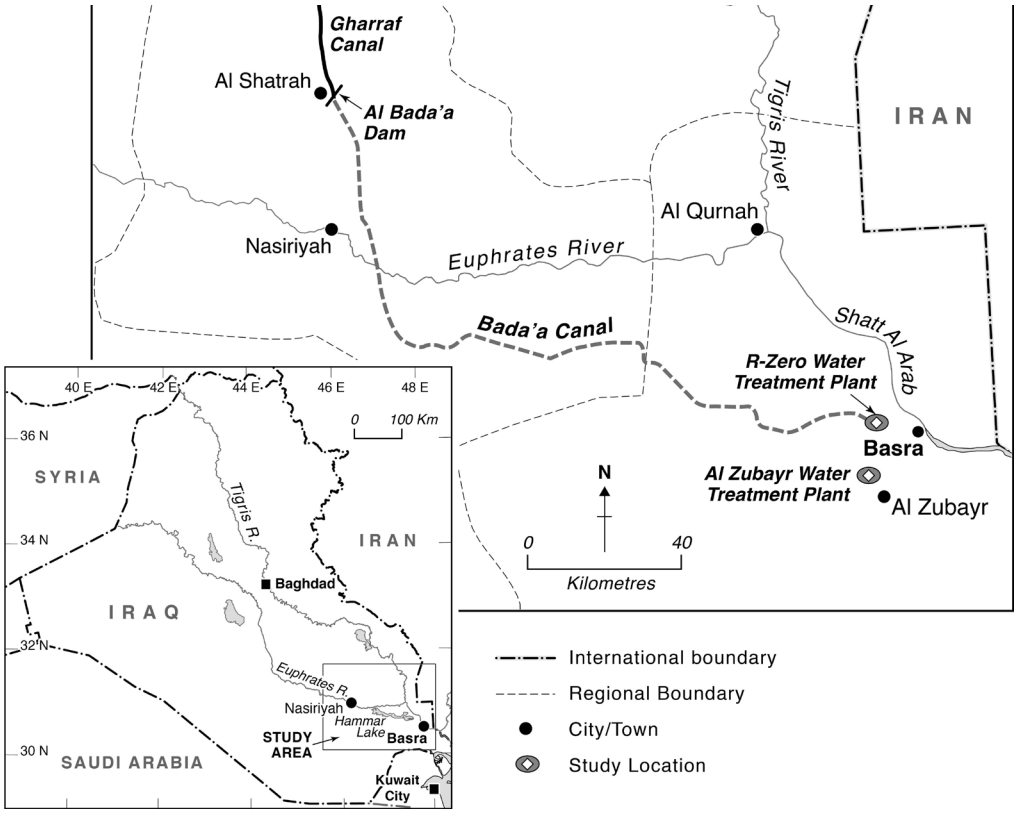
[6] 'Report on Data Collection Survey on Water Sector in Southern Iraq', *JICA* (2015), p. 3–6. Available at https://openjicareport.jica.go.jp/pdf/1000020477.pdf (accessed 16 November 2020).

[7] Interview (online) with Ministry of Water Resources representative, 4 January 2021.

[8] 'Inventory of Shared Water Resources in Western Asia', *UN-ESCWA and BGR* (Beirut, Lebanon, 2013) Available at https://www.unescwa.org/sites/www.unescwa.org/files/publications/files/e_escwa_sdpd_13_inventory_e.pdf (accessed 16 November 2020).

[9] Ibid, p. 162; Li Dinar Abdullah, Usama F. A. Karim, Ilyas Masih, Ioana Popescu and Pieter Van der Zaag, 'Anthropogenic and Tidal Influences on Salinity Levels of the Shatt al-Arab River, Basra, Iraq', *International Journal of River Basin Management* 14/3 (2016), pp. 357–66, DOI: 10.1080/15715124.2016.1193509; Khayyun Amtair Rahi, 'Salinity Management in the Shatt Al-Arab River', *International Journal of Engineering & Technology* 7/4.20 (2018), pp. 128–33, DOI: 10.14419/ijet.v7i4.20.25913.

Figure 2: Major Waterways in Southern Iraq



Map by Mina Moshkeri

The main sources of water in Basra Governorate are the the Shatt-al Arab and the Badaʿa Canal (both of which receive water from the Tigris and Euphrates Rivers). For Basra city and surrounding areas, the main artificial channel of freshwater distribution is the Badaʿa Canal (also known as the Sweetwater Canal). This 240-km open channel was built from 1992–1997. It pumps water from the Gharraf Canal and the Euphrates, feeding into the R-Zero Water Treatment Plant next to Basra International Airport (Figure 2). While designed to boost the quality of water supplied to Basra city, the construction of the Badaʿa Canal was compromised by funding shortfalls caused by the UN economic sanctions regime (1990–2003). This resulted in an incomplete concrete lining to the canal, making the waterway prone to embankment failures. In 2003–4, the US funded limited structural repairs to the Badaʿa Canal as part of a post-invasion commitment to restore water infrastructure in southern Iraq.[10] However, this rehabilitation was insufficient to prevent further deterioration of the canal, accelerated by maintenance neglect and illegal water extraction. In recent years, the rapid accumulation of aquatic plants in the canal, clogging up pumps and filters, has also disrupted expected flows.[11]

[10] 'Umm Qasr Water Scheme', *Special Inspector General for Iraq Reconstruction* (2006), pp. 45. Available at https://apps.dtic.mil/dtic/tr/fulltext/u2/a533626.pdf (accessed 16 January 2021).

[11] Zainab Mehdi, 'Political and Environmental Factors Affecting Southern Iraq's Water Shortages', *LSE Middle East Centre blog*, 4 September 2020. Available at https://blogs.lse.ac.uk/mec/2020/09/04/political-and-environmental-factors-affecting-southern-iraqs-water-shortages/ (accessed 14 January 2021).

The supply capacity of the Badaʿa Canal is regularly cut by flow disruptions, and this was a major contributor to the water crisis in summer 2018. Adoption of the *marashanah* rationing system, involving greater extraction of heavily polluted water from the Shatt al-Arab, overwhelmed the purification capacity of the city's water treatment plants. Following the chronic water crisis in Basra, and pressure from local politicians, the national government, in 2020, announced plans to convert the Badaʿa Canal into a more efficient closed channel system, with work due to be completed by the end of 2021. This project plans to double the flow rate of water delivered to Basra city, reaching 15 m³/second.[12]

Figure 3: Badaʿa Canal, November 2020

Photo: Azhar Al-Rubaie

As there is no alternative freshwater channel for Basra, the Iraqi government has moved to reduce the vulnerability of the water supply system with tenders for large infrastructure projects.[13] The largest commissioned is the Great Basra Water Project, designed to improve water supplies to the cities of Basra and Hartha by rehabilitating and constructing water treatment plants and upgrading distribution networks. Funded since 2008 by development assistance loans from the Japan International Cooperation Agency (JICA), what was

[12] 'Governor of Basra: We Have Agreed with the Minister of Water Resources to Expedite the Completion of the Conversion of the Badaʿa Canal into a Closed Tube Channel', National Iraq News Agency, 4 September 2020. Available at https://ninanews.com/Website/News/Details?Key=854247 (accessed 16 January 2021); 'Minister of Resources for Al-Mirbad: We Included $2 billion in the Budget to Transform the Badaʿa Canal into a Tube', Al Mirbad News, 26 December 2020. Available at https://www.almirbad.com/detail/73779 (accessed 25 May 2021).

[13] Zmkan Ali Saleem and Mac Skelton, 'Basra's Political Marketplace: Understanding Government Failure After the Protests', *IRIS Policy Brief* (2019), pp. 3-5. Available at http://auis.edu.krd/iris/sites/default/files/Saleem%20and%20Skelton%20-%20Basra%27s%20Political%20Marketplace_0.pdf (accessed 14 January 2021).

planned as a six-year project costing US $672 million was still incomplete over ten years later with ballooning costs. An investigation by Human Rights Watch in 2018 noted claims from insiders that corruption was behind delays to the project.[14] Other major investments in public water infrastructure have stalled as a result of alleged corruption and racketeering, such as a reverse osmosis desalination plant at Hartha commissioned in 2014 by the Iraqi government to process 200,000 m³/day of saline water from the Shatt al-Arab.[15]

Repeated governance problems with major projects to scale up the production of public water have not dissuaded the national government from seeking a mega infrastructure silver bullet to solve the water crisis in Basra Governorate. In 2019, the Public Works Ministry awarded an Austrian company the management contract for a seawater reverse osmosis desalination plant at the port town of Al Faw. With a total project value of US $1.8 billion, the desalination plant is scheduled to be completed by 2024 with a world-beating capacity of one million m³/day of 'new water'. The water infrastructure development includes a 240-km transmission system supplying Basra and nine other cities in the governorate.[16] This project has also seen corruption allegations.[17]

3. Compact Treatment Units: The Workhorses of Basra's Water Infrastructure

CWTUs are the dominant technology for water treatment in Basra Governorate, employing pressurised sand filters and chlorinating units to lower turbidity and sterilise water. Since 2003, compact units have been favoured by the Iraqi government and international donors for, it is claimed, their operational resilience. While the treatment capacity of individual units is modest —traditionally 200 m³/hr rising to 400 m³/hr for modern units — compact water treatment is modular, allowing easier transportation, installation and, in principle, maintenance.[18] The total design capacity of public water treatment infrastructure in Basra Governorate is 1.34 million m³/day, although Basra Water Directorate reports actual capacity at 962,631 m³/day. CWTUs supply 83 percent of actual treatment capacity across the governorate and 92 percent of actual treatment capacity in Basra city.[19]

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[14] 'Basra is Thirsty: Iraq's Failure to Manage the Water Crisis', *Human Rights Watch*, pp. 84–5.

[15] Robert Tollast, 'Iraq and the Desalination Revolution: First Steps, Future Trends', *Iraq Energy Institute* (2020). Available at https://iraqenergy.org/2020/05/01/iraq-and-the-desalination-revolution-first-steps-future-trends/ (accessed 16 January 2021).

[16] 'Al Basrah Water Project', *ILF Consulting Engineers*, Presentation at Basra Mega Projects Conference (Istanbul, Turkey, October 2019).

[17] 'Integrity Issues its Report on the Basra Water Project and Holds the Ministry of Construction Responsible for its Delay', *Baghdad Times*, 2020, available at https://www.baghdad-times.net/2020/04/29/النزاهة-تصدر-تقريرها-عن-مشروع-ماء-البص/ (accessed 30 November 2020); 'Suspicions of Corruption Affecting the Basra Water Desalination Project.. The Company Comprises of an Office and Six Employees', *Al Masalah*, 9 March 2021, available at https://almasalah.com/ar/News/206715/--شبهات-فساد-تطال-مشروع-تحلية-مياه-البصرة-الشركة-عبارة-عن-مكتب-وستة-موظفين (accessed 10 March 2021).

[18] Andrea Micangeli, Simone Grego and Stefano Esposto, 'Sustainable Rehabilitation of Water Infrastructures in Southern Iraq after the Second Gulf War' in J. Kauffman and Kun Mo Lee (eds), *Handbook of Sustainable Engineering* (Dordrecht: Springer, 2013), pp. 211–45.

[19] Data from Basra Water Directorate, December 2020.

There are over 300 CWTUs in use across Basra Governorate. Research for this policy brief selected two key water treatment plants to assess their operational performance, collecting water data from the Basra Water Directorate and, in October–November 2020, conducting interviews with water managers and engineers. The two plants chosen were: (a) the R-Zero plant (34 CWTUs) in Al Abbas district (Al Abbas/R-Zero water plant) serving Basra city; and (b) the Al Zubayr plant (or Al Shuaiba Water Treatment Complex) (12 CWTUs) at Al Shuaiba, 8 km south-west of Basra city, which is supplied by R-Zero (Figure 2). In response to the 2018 water crisis, both plants were allocated major funding for compact unit rehabilitation and related upgrades. In 2018, the R-Zero plant received UNICEF funding (from a US $6.1 million grant from the Australian Agency for International Development), while in 2019 Basra Governorate budgeted 983 million dinars (US $674,000) for contract work on the Al Zubayr plant.

(a) The R-Zero (Al Abbas) Water Treatment Plant

R-Zero has the largest concentration of CWTUs in Basra city, equipped with:

- 25 CWTUs with a design capacity of 200 m^3/hr
- 6 CWTUs with a design capacity of 400 m^3/hry

Figure 4: Exterior of the R Zero Water Treatment Plant, November 2020.

Photo: Azhar Al-Rubaie

Figure 5: Interior of the R Zero Water Treatment Plant, November 2020.

Photo: Azhar Al-Rubaie

The R-Zero Plant is a strategic gateway for water distribution from the Badaʿa Canal, receiving up to 26,000–30,000 m³/hr of water. Of this total, 5,000 m³/hr is treated by compact units in the R-Zero Plant for distribution by pipeline to city centre residents. The remaining water, after preliminary filtration, is sent to nine water treatment plants in and around Basra: the Al Zubayr Plant receives the largest single share (4,000–5,000 m³/hr) of this raw water from R-Zero.[20] It is estimated that up to 40 percent of the water distributed by the R-Zero Plant is lost due to leakages and illegal connections.[21]

An immediate cause of the 2018 water crisis in Basra was a sudden drop in flow rates from the Badaʿa Canal: between August and October 2018, the R-Zero Plant extracted water instead from the Shatt al-Arab under the *marashanah* system. The saline and polluted water overwhelmed CWTU capacity, degrading pumps and filters. At the time both *raw and treated* water from R-Zero far exceeded Iraqi water standards.[22] In 2019, UNICEF first funded the emergency rehabilitation of six compact units at a higher water treatment capacity (400 m³/hr) then another ten CWTUs at the standard capacity (200 m³/hr). New water pumps for the plant were funded by the Supreme Religious Authority of Iraq, who decried governmental mismanagement of water in Basra. While these

[20] The other eight water treatment plants supplied by R-Zero are: Al Brad'ia (1,500–3,000 m³/hr), Jubaila (1,500–3,000 m³/hr), Basra Unified (3,000–4,500 m³/hr), Al Hartha (1,500–3,000 m³/hr), Um Qasr (1,000–2,000 m³/hr), Abu Al Khaseeb (1,000–2,000 m³/hr), Abraj Al Hayaniah (1,000 m³/hr) and Khor Al Zubayr (1,000 m³/hr).

[21] 'Minutes of Basrah WASH Coordination Group Meeting, 8 April 2019', *WASH Cluster Iraq* (2019). Available at https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/basrah_wash_cluster_meeting_minutes_8_april_2019_.pdf (accessed 16 October 2020).

[22] For example, the Iraqi standard for total suspended solids (TSS) is 60 mg/l (Law No. 26/1967): in November 2018, the TSS levels at R-Zero were 144 mg/l for raw water and 90 mg/l for treated water. Mean TSS levels from 2014–19 at the plant were 81 mg/l for raw water and 27 mg/l for treated water.

investments created greater system redundancy for future maintenance work, the water treatment capacity of R-Zero remained at 5,000 m^3/hr, constrained by the plant's share of the limited flows from the Badaʿa Canal.

Furthermore, water treatment based on assemblies of multiple CWTUs has been inefficient. Compact units can last up to 20 years, but Iraqi water engineers report that continuous and costly maintenance is necessary after only five years of operation. Half of the CWTUs at the R-Zero Plant are over 15 years old and running below their design capacities for water treatment. While there are no reported shortages of aluminium sulfate (alum) and chlorine, old compact units regularly malfunction, and there are often delays in securing spare parts attributed to lengthy governmental approval processes. Given low levels of staffing, the operation and maintenance of CWTUs is very challenging, negatively affecting the capacity to treat water at a reliable level of quality. R-Zero is facing delays over the installation of a programmable logic controller system, which in principle would mitigate operation and maintenance constraints by digitalising real-time controls over the water treatment process. The plant also needs to replace its heavily corroded main water collection basins.

(b) The Al Zubayr (Al Shuaiba) Water Treatment Plant

As noted above, the Al Zubayr plant receives 4,000–5,000 m^3/hr of 'raw water' from R-Zero.

The plant is equipped with:

- 4 CTWUs with a design capacity of 400 m^3/hr
- 8 CTWUs with a design capacity of 200 m^3/hr

Figure 6: Al Zubayr Water Treatment Plant, November 2020

Photo: Azhar Al-Rubaie

Figure 7: Al Zubayr Water Treatment Plant, November 2020

Photo: Azhar Al-Rubaie

The Al Zubayr Plant illustrates the governance paralysis that regularly affects water management in Basra Governorate. In November 2019, the Provincial Council budgeted 983 million dinars (US $674,000) for essential maintenance and rehabilitation works, but for reasons unclear, this money was not forthcoming. No major rehabilitation work has taken place at the plant since UNICEF funded the rehabilitation of four CWTUs in 2008, which have since been taken out of service. In 2020, none of the 12 compact units were operational: this meant that the raw water supplied by R-Zero received at best some chlorine treatment before distribution to residential areas in Al Zubayr district, yet remained undrinkable. As households in Basra city have long relied on private vendors for potable water, so do residents of Al Zubayr. A major alternative source is desalinated water sold to vendors by a petrochemical plant in the large Zubayr oil field (in 2008, the UK's Department for International Development and UNICEF co-funded an upgrade of its water filtration equipment). In spring 2020, during a coronavirus wave, Al Zubayr municipality and Basra Oil Company provided free supplies of this desalinated water for citizens unable to access supplies.[23]

Rapid population growth in Al Zubayr district has outstripped the operational capacity of the water treatment plant at Al Shuaiba and a smaller local plant at Al Khitwa, which has five CWTUs treating up to 1,200 m^3 (rehabilitated in 2009–2011 with funding from the UK Department for International Development).[24] Water engineers report that the Al Shauaiba water treatment plant needs complete rehabilitation, including new pumps, water collec-

[23] 'A Campaign to Distribute Free Drinking Water to Citizens West of Basra', *Mawazine News*, 26 March 2020. Available at https://www.mawazin.net/Details.aspx?jimare=92079 (accessed 21 January 2021).
[24] 'Development Tracker: Az Zubayr Water Treatment Plant', *Foreign, Commonwealth and Development Office*, 2021. Available at https://devtracker.fcdo.gov.uk/projects/GB-1-201260 (accessed 21 January 2021).

tion basins and additional compact units supplying at least an additional 2,000 m³/hr of water. There is also a need for new transmission lines both from R-Zero to Al Zubayr and also to the local areas supplied by Al Zubayr. However, the goal of greater water treatment capacity again hits the *volumetric constraint* of the limited and variable capacity of Badaʿa Canal supplies, as delivered by the R-Zero Water Treatment Plant through an old and unreliable distribution network. The short-term priority for the Al Zubayr plant is to activate at least some of its dormant CWTUs: given humanitarian concerns over a failing local network for public water treatment, the United Nations Development Programme agreed to fund the rehabilitation of four compact units in 2021.

Improving the Performance of CWTUs

The production of safe, clean water by water treatment plants is dependent on the operational performance of compact units in treating the raw water supplied. Treatment of Badaʿa Canal raw water has tended to result in satisfactory water quality for the R-Zero and Al Zubayr CWTU plants, but the sourcing of saline and polluted raw water from the Shatt al-Arab is mainly responsible for the failure of water treatment plants in Basra city (both conventional and CWTU) to produce adequate drinking water.[25] Without being able to address this raw water quality, the focus has been on plant-specific conditions of operation. Post-2003 humanitarian assessments of CWTU plants in southern Iraq recommended improving their operational resilience by maximising the use of local chemicals and other resources, e.g. substituting chlorine gas with sodium hypochlorite produced in situ and substituting the sedimentation treatment stage with low-maintenance rough filtration.[26] These technical suggestions are largely superseded by the type of new generation compact units slowly being introduced; for example, the three DynaSand compact units installed at R-Zero are designed to deliver high capacity water treatment with low-energy and low-maintenance demands. None of the water managers and engineers interviewed for this policy brief expressed a concern related to access to chemicals (or energy).

A greater threat to the operational autonomy of the water treatment plants is the issue of project delays from state funding and lengthy bureaucratic procedures. This was the principal concern at the two CWTU plants studied and research suggests that this problem is replicated in other water treatment plants. The biggest supply constraint to the two CWTU plants — shared by eight other CWTU plants sharing the same source — is that they are dependent on, and are limited by, the total water supplied by the Badaʿa Canal to R-Zero (no more than 30,000 m³/hr and sometimes less than 26,000 m³/hr). As the long-awaited conversion of the Badaʿa Canal to a closed channel would double this capacity (54,000 m³/hr), this single infrastructure measure would allow a major upscaling of CWTU treatment capacity.

[25] Suhad Almuktar, Ahmed Naseh Ahmed Hamdan and Miklas Scholz, 'Assessment of the Effluents of Basra City Main Water Treatment Plants for Drinking and Irrigation Purposes', *Water* 12/12 (2020), DOI: https://www.mdpi.com/2073-4441/12/12/3334.

[26] Stefano Esposto, 'Sustainability Applied to the Design of Water Treatment Plants in Iraq', *Sustainability Science* 4/2 (2009), p. 293–300, DOI: https://doi.org/10.1007/s11625-009-0075-3; Micangeli, Grego and Esposto, 'Sustainable Rehabilitation of Water Infrastructures in Southern Iraq after the Second Gulf War'.

4. A Mega-Infrastructure Future for Supplying Public Water?

In Basra Governorate, the growing role of CWTU plants in the treatment and supply of public water reflects repeated delays in realising a mega infrastructure solution to the water crisis. The public water network is a critical infrastructure vulnerable to cascading failures as a result of system-wide capacity deficits and interdependencies.[27] Since the 1990s, most Basra city residents have bought private water for drinking, on account of regular interruptions to supply and doubts over the quality of tap water. There are more than 30 private water treatment plants (using mainly reverse osmosis desalination) in the city which sell water through shops or directly from water tankers.[28]

Figure 8: Private water tanker delivering water in Basra, November 2020

Photo: Azhar Al-Rubaie

At the same time, demand for domestic water in Basra city and Governorate is rising with rapid demographic growth (over 2 percent per annum), largely because of migration from other parts of Iraq. In this section, drawing on interviews with individuals responsible for, or contesting, water governance, we call for a regional move to *system-wide resilience* rather a mega infrastructure fix. Three necessary elements for this transition are: (1) supply diversification; (2) multidirectional connectivity and (3) effective governance.

[27] On the mapping of critical infrastructure failure see: Raghav Pant, Scott Thacker, Jim W. Hall, Stuart Barr, David Alderson and Scott Kelly, 'Analysing the Risks of Failure of Interdependent Infrastructure Networks' in J. Hall, M. Tran, A. Hickford and R. Nicholls (eds), *The Future of National Infrastructure: A System-of-Systems Approach* (Cambridge: Cambridge University Press, 2016), DOI: https://doi.org/10.1017/CBO9781107588745.013.

[28] In 2020, the price of one ton of water (1,018 litres) was 8,000–10,000 dinars (US $5.50–$6.80) from private water vendors in Basra city. Residents on low incomes are forced to use tap water.

1. Supply Diversification

A sustainable public water infrastructure in Basra Governorate requires the diversification of water supply sources to create system-wide robustness against negative long-term trends in surface water availability (e.g. from upstream damming and projected climate change effects) and disruptive short-term events (e.g. pumping failures or flooding). Construction of the planned desalination plant at Al Faw would create a major supply asset in the regional public water infrastructure, but this could also generate a single-source dependency without investments in the wider network of water treatment and supply. These additional measures include timely completion of the donor-funded Great Basra Water Project and the Badaʿa Canal conversion, as well as upgrades in the operational efficiencies of CWTUs from the replacement and rehabilitation of units. Some interviewees raised the suggestion of greater secondary water storage to reduce the risk of supply shocks. The Badaʿa Canal has three storage basins that, in the event of a collapse in flows, can supply Basra city for an additional five days.[29] This emergency storage capacity will need to be boosted for a converted canal doubling discharge rates.

Interviewees also claimed that there is substantial scope in Basra Governorate for wastewater recycling for industrial, agricultural and household use. Oil companies withdraw large amounts of water from the Shatt al-Arab, injecting this into oil fields to boost extraction rates. As noted by an environmental scientist interviewed, modern techniques of water recycling for oil injection — as used, for example, by Exxon Mobil in the West Qurna Field west of Basra city — could greatly reduce these industrial demands on surface water.[30] Biological treatment of sewage wastewater has potential to support agriculture in water-stressed agricultural areas:[31] In the south of Basra Governorate, a lack of alternative water sources is driving many farmers to abandon agricultural livelihoods.[32] Ecological treatment technologies can recycle wastewater for domestic as well as agricultural use. They can also contribute simultaneously to community regeneration and ecological restoration. For example, the Eden in Iraq Wastewater Garden project has created a promising community template for water remediation in southern marshland environments.[33]

2. Multidirectional Connectivity

Public water infrastructure in Basra Governorate has a high degree of dependence on supply flows from sources originating outside the governorate. The northern districts of Al Quorna and Al Medaina withdraw water directly, from the Tigris and Euphrates respectively. Most central and southern districts, including Basra city, have relied since the later

[29] Al-Mahmod, 'Water Resources in Basra and its Recent Problems', p. 88..

[30] See also: Robin Mills and Mohammed Walji, 'Muddy Waters: Iraq's Water Injection Needs', *Iraq Energy Institute* (2018). Available at https://iraqenergy.org/product/muddy-waters-iraqs-water-injection-needs-report/ (accessed 11 January 2021).

[31] Muhsin A. J. Al-Mossawi, 'Biological Approach to Recycling Waste Water in Iraq', *Air, Soil and Water Research* 7 (2014), pp. 111–15, DOI: https://doi.org/10.4137%2FASWR.S17611.

[32] 'Iraq: Basra Fact Finding Mission Report #3', *Norwegian Refugee Council* (2018). Available at https://reliefweb.int/report/iraq/iraq-basra-fact-finding-mission-report-3 (accessed 15 November 2020).

[33] 'Eden in Iraq Wastewater Garden Project'. Available at https://edeniniraq.com (accessed 21 January 2021).

1990s on raw water from the Badaʿa Canal and the Shatt al-Arab. Due to the very poor quality of water from the Shatt al-Arab, the limited and irregular flows of the Badaʿa Canal amplify a system-wide vulnerability to this single supply node. Interviewees in Basra argued that additional connectivity is necessary to build the resilience of the public water network. This would involve multidirectional supply connections from the south and north, supported by equitable transboundary flows:

- *Southern supply connections*: The large desalination plant planned at Al Faw will significantly improve water supply connectivity in the south of Basra Governorate. This was recognised by several interviewees as potentially a major contribution to efforts to increase the availability of potable water. From the pumping station at Al Faw, a 340 km network comprising one trunk line and five branch lines will feed nine offtake stations (total storage capacity of 500,000 m^3) connecting to exiting local distribution lines. Significantly, the planned Al Faw transmission system will remove the need for water plants located next to the Shatt al-Arab to withdraw water from this source.[34] Two of the offtake stations are in Basra city and another is located in Al Zubayr, which would create system-wide redundancy (back-up capacity) alongside flows from the Badaʿa Canal.

- *Northern supply connections*: Water engineers interviewed highlighted the importance, if completed, of supply connections north of Basra city, notably JICA-funded rehabilitation of transmission and distribution networks associated with a planned new water treatment plant at Al Hartha (with a design capacity of 340,000 m^3/day). This is a core, yet delayed, element of the Great Basra Water Project. It would move the main withdrawal of water from the Shatt al-Arab for purification upstream from Basra city, with treatment benefitting from lower levels of organic pollution in the raw water.

- *Equitable transboundary flows*: Transboundary impacts on water availability in Basra Governorate were raised by research interviewees, though climatic stresses were mentioned more than upstream damming of the Tigris, Euphrates and Karun Rivers.[35] An official from the Environmental Protection Department (Ministry of Health) highlighted dam-building in Turkey as a serious concern. Iraq has a 1990 bilateral agreement with Syria on sharing water from the Euphrates, but a 2009 memorandum of understanding with Turkey on water management has a narrow technical scope and there is no water sharing agreement with Iran. Since September 2020, Iraq's Minister of Water Resources has led a delegation negotiating on transboundary water issues with neighbouring states. In March 2021, it was announced that Turkey had agreed to release fair water shares to Iraq.[36] Syria and Iran should also cooperate in good faith with Iraq on the equitable and reasonable use of shared water resources consistent with international water law.

[34] 'Al Basrah Water Project', *ILF Consulting Engineers*.

[35] For an analysis noting a significant influence of climatic factors, see Mejs Hasan, Aaron Moody, Larry Benninger and Heloise Hedlund, 'How War, Drought, and Dam Management Impact Water Supply in the Tigris and Euphrates Rivers', *Ambio* 48/3 (2019), pp. 264–79, DOI: https://doi.org/10.1007/s13280-018-1073-4.

[36] 'Iraq: Turkey Agrees to Release a Fair Share of Water to Our Lands', *RT Arabic*, 14 March 2021. Available at https://arabic.rt.com/middle_east/1211357-العراق-تركيا-وافقت-على-إطلاق-الحصة-المائية-العادلة-لأراضينا (accessed 16 March 2021).

3. Effective Governance

Interviewees in Basra identified governance failings as the main reason for the ongoing water crisis, encompassing both shortfalls in governance authority and capacity. Most of the blame was attached to successive regional (provincial) governments, which have struggled to maintain peace and order. However, the political landscape in Basra mirrors the wider post-2003 political settlement in Iraq (the *Muhassasa al-Taʾifia*), which comprises a contested, often chaotic, distribution of state offices and resources between rival ethno-sectarian actors.[37] Over the last decade, various Shiʿa Islamist parties and their militias have fought for control of public assets and contracts in Basra Governorate, with regular use of means of violence.[38] The scope of formal rent-seeking rises and falls with oil prices, although extortionist practices are also a lucrative source of income, especially in the oil and gas sector. Public water projects are not immune from racketeering demands from tribal groups and sectarian militias, generating significant delays for initiatives designed to upgrade treatment and supply infrastructure.

Unconsolidated state authority is responsible for, and reinforces, widespread illegal extraction from public water networks, increasing operational costs and reducing water pressure. In research interviews, water engineers identified illegal tapping as a major contributor to the loss of water in public distribution networks. Largely ignored by administrative and judicial bodies, this illegal tapping encompasses individual households, businesses and large agricultural enterprises: it compounds risks to public health from water contamination. However, illegal tapping is not simply an issue of the lack of enforcement of laws governing water usage; it also reveals the inequalities of water availability in Basra. Over 470,000 of the governorate's population is not connected to piped water networks.[39] The illegal tapping of waterways and pipelines by residents of 'unapproved housing' (*hawasim*) often exposes these communities to untreated water, yet poorer households may not have ready access to potable water or be able to afford it from private vendors. A lack of government investment in the maintenance and extension of public water networks has aggravated the problem of affordable access to clean water. There is a need for an independent, impartial review of public water management in Basra Governorate to determine key challenges and to offer governance recommendations based on inclusive and open dialogue with affected communities.[40]

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[37] Toby Dodge and Renad Mansour, 'Sectarianization and De-Sectarianization in the Struggle for Iraq's Political Field', *The Review of Faith & International Affairs* 18/1 (2020), pp. 58–69, DOI: https://doi.org/10.1080/15570274.2020.1729513.

[38] Zmkan Ali Saleem and Mac Skelton, 'Basra's Political Marketplace: Understanding Government Failure After the Protests', *IRIS Policy Brief* (2019). Available at http://auis.edu.krd/iris/sites/default/files/Saleem%20and%20Skelton%20-%20Basra%27s%20Political%20Marketplace_0.pdf (accessed 16 January 2021).

[39] Data from Basra Water Directorate, February 2021.

[40] See, for example, 'OECD Water Governance Indicator Framework', *OECD* (2018). Available at https://www.oecd.org/regional/OECD-Water-Governance-Indicator-Framework.pdf (accessed 17 March 2021).

5. Conclusion

The public water network in Basra Governorate is a critical but neglected infrastructure. Crucial for the delivery of essential water services to the population, its deterioration over decades is a result of armed conflict, international sanctions and deficient governance. In Basra city, tap water has been undrinkable since the 1990s, forcing most households to rely on private water vendors. Water infrastructure upgrading was a priority for state-rebuilding after the 2003 invasion but receded under the civil war. Governmental and donor plans for mega infrastructure water projects have stalled in the face of systemic corruption. CWTUs are the dominant treatment technology, supplying 83 percent of treatment capacity across Basra Governorate and 92 percent in Basra city. The efficiency of CWTUs supplying Basra city is restricted by irregular flows from the Badaʿa Canal to the key conduit of the R-Zero water treatment plant. These flows are impacted by upstream dam construction, climatic variability and illegal water tapping. The operational capacity of CWTUs is also limited by under-investment in their maintenance, often reducing their working life to 10–15 years. In the face of high population growth in southern Iraq, there is a pressing policy need to diversify water sources for Basra and improve the efficiencies of treatment technologies and distribution networks. A key lesson over recent decades for public water infrastructure is the need to avoid reliance on a single source of water.

Many of the water infrastructure failings identified in this policy brief are not unique to southern Iraq, but there are critical vulnerabilities compounded by the volatile political context. Before offering new grants or loans for major infrastructure projects, donors should support an independent review of public water management in Basra Governorate to determine the feasibility of effective and efficient assistance.

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