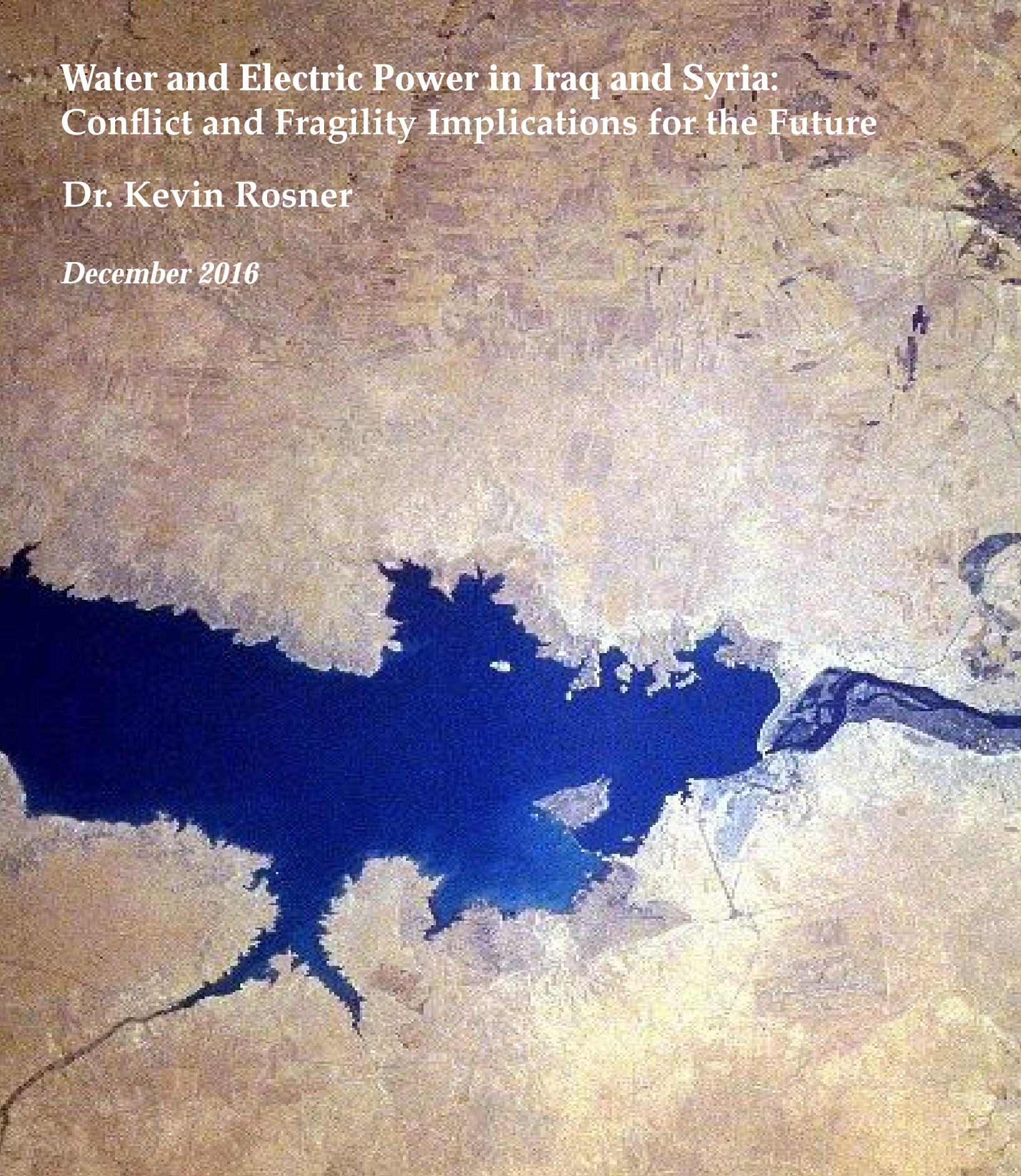


Water and Electric Power in Iraq and Syria: Conflict and Fragility Implications for the Future

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About the Paper

This paper is published as part of the Strauss Center's program on Middle East Water, Energy, and Security, which explores the nexus of security and development in the Middle East. The program is led by the Strauss Center's State Fragility Initiative Director Ashley Moran. This pilot study led by Dr. Rosner seeks to understand the exact scope and location of water and energy resource stress in the region, the implications for livelihood and state security, and the required elements for stability in the face of growing resource stress. It focuses on Iraq and Syria as two countries that are central to water, energy, and conflict dynamics in the region. More information about the Strauss Center's Middle East program can be found at www.strausscenter.org/programs.

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Key Message

As we move further into the 21st Century, resources around the world—particularly water and electric power—are increasingly stressed by population growth and by the spatially uneven impacts of climate change. In this environment, the lessons unfolding in Iraq and Syria attest to the need for a deep understanding of the essential role of these resources in societal interactions and of the impact of their militarization. This study advocates an approach that calls attention to these resources and the complexities they present for reducing and rebuilding after conflict. It moves the discussion beyond problem definition to present a coordinated methodology for disaster response and post-conflict reconstruction with the nexus of these water and energy resources in mind. The study identifies that:

- There is a need for an integrated security framework applied to water and electric power resources.
- This framework must be multi-scalar, described herein as having primary, secondary, and tertiary levels of data collection and analysis.
- This framework is a holistic approach that demonstrates the connectivity between water and electric power complexities on different scales.
- The methodologies highlighted here for research ‘at scale’ have already been tested and thus provide a proof of concept for the proposed integrated security framework methodology.

Water and Power Key Take-Aways

Section One. Hydrology and Water Demand Growth in the Euphrates-Tigris

- A combination of complex hydrological and demographic factors are contributing to increasing water stress and energy paucity across the combined Euphrates-Tigris basins. Understanding the dynamics of these factors, and potential solutions, is key to the future of the region.
- The shared implications of climate variability in the Fertile Crescent could potentially unlock opportunities for transboundary cooperation in the water space and, in turn, greater regional stability.
- Establishing a baseline in understanding of the current state of water and electric power resources in Iraq and Syria today is key to rapid and efficient recovery of these fundamental resources and services for the region’s population in a post-conflict environment.

Section Two. Iraqi and Syrian Water, Conflict, and Fragility

- Peace and security in Iraq and Syria would benefit fundamentally from a detailed socio-economic case study of the water and electric power contexts in these states.
- Improved understanding of the capacity of critical water and electric power infrastructure in Iraq and Syria along their entire supply chains could assist in improving the security of the region's people now and after the current conflict.
- This study finds that the seizure and control by ISIS of water and electricity assets were of a second order of magnitude to territorial conquest and the declared establishment of a caliphate. In short, Iraq and Syria are not resource wars but wars in which resource seizure, control, and exploitation have contributed to the depth, intensity, and duration of conflict.
- An in-depth study is required to fully detail how water and electricity infrastructure contributed to ISIS' ability to control territory and how to prevent this from occurring in the future.

Section Three. Electricity in Iraq and Syria

- The policy and institutional structure of power generation, transmission, and distribution will mirror political changes in post-conflict Iraq and Syria. Adjusting to and accommodating these changes is a pre-condition to post-conflict infrastructure reconstruction and represents a learning curve that the international community can start preparing for now.
- This study calls for a comprehensive assessment of Syrian electrical power-generating facilities moving forward from both a risk assessment and a technical assessment standpoint.
- Understanding the social dimensions of energy—including the impact of debilitated energy infrastructure on water quality, water availability, and overall human health—is key to framing and prioritizing solutions during reconstruction.
- It appears that both Syria and Iraq would benefit from transboundary power sharing, however the political and economic implications of carrying this forward, particularly with respect to Iran as a partner in the region, require further assessment.

Section Four. Back to the Future: Energy, Water, and Human Security

This study highlights the following lessons from the Iraq reconstruction experience that are of particular salience for future water and energy reconstruction efforts in the region.

- Understanding government institutions and the structure of decision making is critical for determining what is needed for restoring essential services such as electricity and water.

- Assessments of a country's economy, agriculture, social structures, and other aspects of the operating environment are essential for a holistic assessment of the reconstruction environment.
- Successful assessment and rebuilding of network systems must consider the political, socio-economic, and demographic landscapes that gave rise to water and energy network systems in the first place.
- There is a need for both doctrine and structure to guide reconstruction efforts. However, both doctrine and structure should be flexible enough to accommodate the specific environment in which they are to be applied.
- Carrying out reconstruction efforts in an environment experiencing ongoing conflict is not only difficult but expensive.

Executive Summary

This pilot study, *Water and Electric Power in Iraq and Syria: Conflict and Fragility Implications for the Future*, is intended for development professionals, defense and security analysts, scholars, and others interested in the state of these network systems as impacted by political instabilities and conflict in Iraq and Syria. The study is action oriented and solutions driven. It seeks to inform decision making through the promotion of an approach that embraces complementary methodologies at different scales. It embraces a full picture of the complexities of the water-energy challenge and the multiple dimensions of potential solutions offered.

This study provides admittedly an incomplete analysis of the multiple water and electric power challenges in Iraq and Syria. Like all work in this conflicted geography, it is hindered by the lack of available information, lack of access to locations where data should be acquired, and—in the particular case of water and power—lack of sufficient information available prior to the onset of conflict needed to accelerate recovery and rebuilding of the operational capacity of these network systems in a post-conflict period.

Overall access to potable water and uninterrupted electric power in both Iraq and Syria is poor at best or non-existent altogether as a function of location. Even in the absence of war, Syria and Iraq are among the most arid in the world, ranking 150th and 155th respectively in terms of all countries in the world with the least amount of precipitation per year. And this is getting worse. A detailed analysis of the worsening hydrology of the region, and the pre-conflict absence of transboundary water management mechanisms, could positively inform post-conflict solutions where water resources are concerned.

The electric power systems in both countries find themselves in a state similar to that of water. It may be early to talk about a post-conflict Iraq—with the ongoing battle for Mosul underway as of this writing—but both during and even before the conflict, the country has remained woefully under-supplied with electric power, which is both a pre-requisite and a driver of economic growth in the future. Syria's power grid equally suffers from supply capacity constraints.

Infrastructure in both countries has seen extensive and punishing destruction from the slash-and-burn tactics of the Islamic State of Iraq and Syria (ISIS) forces as they retreat from territory they once controlled. There will be a political and institutional vacuum created by ISIS retreat with different international, national, regional, and local actors vying for influence and control over what ISIS leaves in its wake. This future reality can be proactively addressed in plans for infrastructure moving forward.

This study provides specific recommendations for steps that can be taken now to improve water, energy, and human security in Iraq and Syria both now and in the post-conflict period. This study recommends that the international community—i.e. development agencies, UN institutions, development banks, national governments in and outside the region, and other interested actors—should:

- Act on the reality that stressed water resources in the Euphrates-Tigris Basin have long-term security implications for the region. Specifically, the international community should determine the extent to which engineering and policy responses may positively mitigate water stress on the region's population and act on these recommendations accordingly. If water resources are not properly managed and water stress not subsequently reduced, lack of action could contribute to reigniting political instabilities in a post-conflict environment.
- Study and prepare for the multiple impacts that would follow from the high probability that the Fertile Crescent will decrease in size and may disappear altogether by the end of the 21st Century. The persistent droughts that could affect the size and longevity of the Fertile Crescent have geostrategic implications for the region and potentially for the global community. In short, the international community should contain this threat regionally in the medium term or be prepared to address the long-term global consequences of the potential permanent resettlement of millions of people from inside the Fertile Crescent to outside the region due to this climate-related event.
- Systematize data acquisition on the physical state of water treatment and distribution facilities, electric power generation and distribution systems, and other critical nodes in Syria's and Iraq's water and energy infrastructure, as these facilities are directly linked to the human security of the populations they service.
- Assess the current state of water and power systems in both countries to determine how much reconstruction or new-build construction will be required for the Iraqi and Syrian economies to recover into the future.
- Examine the fuel-power generation supply chain in both Iraq and Syria to assess prospects for alternative fuels to meet current gaps in fuel and/or power sector needs.
- Acknowledge that water and electric power resources—and access to them in both Iraq and Syria—have been subject to discriminatory practices in the past. The international community must ensure, through adequate and judicious enforcement of egalitarian public policies, that there is equal distribution of and access to these resources in the future.
- Acknowledge that ISIS' exploitation and militarization of natural resources have been a means to its larger goal of territorial control and defensive maintenance of territory. Defense and security organizations should prepare tactically and strategically to ensure these actions are not replicated by the same or similarly inspired groups in the future.

- Assess the economic and political implications in the Iraqi and Syrian power sectors of potential future dependence on Iranian natural gas exports and Iranian electricity exports.
- Anticipate that governance over Iraq's and Syria's electric power systems may change in the future as a result of new political and administrative realities on the ground. The international community should configure development policy options accordingly.
- Create a commission to evaluate the lessons learned from the Iraq Reconstruction period for application in a future Syrian post-conflict context. This commission should consider how best to: (i) Establish a multi-scalar, stratified approach to damage assessment and infrastructure recovery; (ii) Establish consistent doctrine and structure for relief and reconstruction operations; these should include input from multiple sectors and should be field-tested in whole or in part by activities of the Global Coalition Against Daesh in Iraq and Syria; and (iii) Account for links between agricultural, industrial, and economic activities and their water and electric power requirements.

Introduction

Overview

The following paper provides a pilot study of water and electric power assets—consisting of both resources and related infrastructure—in Iraq and Syria as best as can be determined with information presently available. The study details how these network systems have been impacted by years of conflict that continues to engulf them. This study further notes that water and in particular hydroelectric facilities (dams) have at one time or another been weaponized by conflict belligerents. As a pilot study, this work seeks to provide a way forward to understanding more completely how the debilitation, or in some cases outright destruction, of these assets contributes to the instability and fragility of the Iraqi and Syrian states. Most crucial and fundamental is how the lack of universal access to and availability of potable water puts at risk members of the populations of both countries. The precarious state of water is directly impacted by infrequent electricity supply required for both its treatment and distribution (pumping). Finally, where water is concerned, the study further addresses the environmental impact of climate change on the hydrology of the part of the Fertile Crescent in Mesopotamia. If these climate change forecasts occur as they are projected, their impact on the region’s political, economic, and social stability will be of a magnitude far greater than present instabilities driven by civil war and insurgency.

The study’s findings seek to assist international organizations, government agencies, non-governmental organizations, and private industry in thinking through the provision of sustainable water-energy solutions in response to both immediate and longer-term water and energy needs in Iraq and Syria. It is a study that pivots on the conviction that a holistic understanding of complex problems is the first step towards developing inclusive and informed solutions. By engaging experts in human geography, water and power engineering, and other disciplines, a multi-scalar intelligence-gathering process can inform a holistic approach to defining the challenges and planning policy options. The end goal of this study is to contribute to improving conflict assessment, infrastructure recovery, and above all the safety and security of populations caught in the Iraqi and Syrian conflicts.

As noted, this is a pilot study, which by definition is a small-scale version of a potentially much larger project. Its purpose is to test the viability of its research design, which if expanded could ultimately deliver sufficient data findings to help serve the needs of multiple end-users. The end-user community of stakeholders for this work includes, for example, both civilian development and reconstruction professionals and defense-related organizations such as the U.S. Army Corps of Engineers—all of which can assist in the recovery of critical infrastructure and delivery of resources to improve the security of human populations in Iraq and Syria. Where sufficient data is available, it is provided. Where data is unavailable but deemed essential to satisfactory delivery of improved water and energy resources in this region, a relevant research question is provided in order to frame and guide potential follow-up in the form of extended research.

Finally, the study's final section highlights several lessons learned from the Iraq Reconstruction experience that can be applied to improve ongoing recovery and reconstruction activities in that country and that could be applied in a post-conflict Syria in the future.

Why Iraq and Syria

The countries of Iraq and Syria share a number of similarities which taken together provide a useful framework of analysis. Geographically, these states share the Tigris-Euphrates Basin—home to the ancient civilization of Mesopotamia (from the Greek meaning ‘between two rivers’) bordered in the east by Iran and in the west by Syria and by definition enveloping the present state of Iraq in between.

The region has historically suffered from an absence of regional or transboundary water governance institutions and agreements, leading to friction between the riparian states of Turkey, Syria, Iraq, and Iran,¹ which are among the most arid countries in the world. For example, in a study of 167 countries examined in 2008, Syria and Iraq ranked 150th and 155th respectively in terms of the countries in the world with the least amount of precipitation per year.² Arid Syria and Iraq are downstream from Turkey, and therefore water available for hydropower production is a function of both upstream water release from Turkey and variations in climate-impacted water availability downstream in these regions. Both countries are ruled by Shia-aligned governments that govern sizable Sunni populations. In the post-Saddam Hussein period, Iraq has been led by Shia governments overseeing a Shia majority and sizable Sunni Arab and Kurdish minorities. Under the current Assad regime, Syria is ruled by an Alawite-led government that oversees a majority-Sunni population.

Under current ongoing crises, both the Iraqi and Syrian regimes have experienced strategic failure by allowing for the militarization of some of their critical water and electricity sector infrastructure, and other related resources like oil, by ISIS and other conflict belligerents. Natural resources have been used in Syria and Iraq by all parties to the conflicts as tactical military assets (weaponry) to punish or thwart their adversaries.³ The use of water resources as a weapon of war led the UN Secretary General to decry in 2014 that, “Preventing people’s access to safe water is a denial of a fundamental human right,” noting that “deliberate targeting of civilians and depriving them of essential supplies is a clear breach of international humanitarian and human rights law.”⁴ Perhaps most ominously, weaker parties have realized that, particularly in modern societies, striking ‘soft targets’ causes the greatest damage. Consequently, civilian targets frequently replace military

¹ Peter Gleick, “Water, Drought, Climate Change, and Conflict in Syria,” *Weather, Climate, and Society* 6, 3 (2014): 331-340.

² “Countries Compared by Geography > Average rainfall in depth > Mm per year, International Statistics at NationMaster.com,” Aggregates compiled by NationMaster (Rome: Food and Agriculture Organisation, 2008). Available at: www.nationmaster.com/country-info/stats/Geography/Average-rainfall-in-depth/Mm-per-year.

³ Walaa Hussein, “How IS Uses Water as Weapon of War,” *Al Monitor*, May 11, 2015.

⁴ Thalif Deen, “Africa: UN Decries Water as Weapon of War in Military Conflicts,” *AllAfrica*, May 19, 2014.

ones.⁵ Water and electric power assets have been regularly targeted by one force to gain advantage over another.

Conflict actors have ‘systemized’ natural resource exploitation as a means of taxing and spending—selling or leveraging seized assets to finance hybrid warfare and conventional violence in the Middle East. This is an advanced and sophisticated system that extracts value along the entire resource supply chain to the benefit of the asymmetric terrorist or criminal enterprise. The use of seized oil field assets in Syria is a prime example of this practice⁶ and demonstrates just how important financial assets and cash flow have been to the growth of asymmetric groups. These and other actions that leverage the exploitation of natural resources have emerged concurrent with increased (conventional) stress on strained resources (electric power, water, and even food) from demographic, economic, and environmental casual factors. There are therefore two lesson-categories to be exploited from the Iraq experience for application moving forward. The first is the military, strategic dimension, where we now know the implications of losing control over key water and energy assets and their sophisticated exploitation by ISIS for military purposes. Failure to learn from this lesson only heightens the risk that legitimate governments will face a similar challenge or threat in the future if preventative actions are not taken when appropriate. The second lesson is that ad hoc, poorly planned reconstruction can lead to large-scale financial and material waste, as demonstrated in the Iraq reconstruction experience. The United States spent \$52 billion on Iraq reconstruction with the majority of Iraqis and U.S. experts left with the impression that there is little to show for it.⁷

One result of protracted conflict involving water and energy assets, and their partial debilitation or complete destruction, is that they need to be rebuilt or replaced with new-build construction. This involves huge financial liabilities incurred by the international community and the states in question but at the same time holds out a potential positive outcome for recovery if pursued in a sustainable fashion. If future reconstruction in Syria is to proceed—and at some point in the indeterminate future it must—then above all the lessons from Iraq should be heeded. By all accounts the reconstruction of water and power assets in Iraq was beset by “multiple miscalculations, poor planning, disorganization in Washington, and inadequate consultation with Iraqis.”⁸ The report by the Special Inspector General for Iraq Reconstruction is instructive both in terms of what not to do as well as what to prepare for in advance of any post-conflict reconstruction where critical infrastructure—particularly where water and power—are concerned.⁹ As one

⁵ Toni Pfanner, March 2005, “Asymmetrical Warfare from the Perspective of Humanitarian Law and Humanitarian Action,” *International Review of the Red Cross* 87, 857 (2005): 149-170.

⁶ Organisation for Economic Co-operation and Development (OECD), *Terrorism, Corruption, and the Criminal Exploitation of Natural Resources* (Paris: OECD, 2016).

⁷ R. Jeffery Smith, “The Failed Reconstruction of Iraq,” *The Atlantic Monthly*, March 15, 2013.

⁸ Ibid.

⁹ Special Inspector General for Iraq Reconstruction (SIGIR), *Hard Lessons: The Iraq Reconstruction Experience* (Washington: U.S. Government Printing Office, 2009).

example, the U.S. military is instituting measures to account for post-conflict environmental impact in this regard.¹⁰

Section Breakdown

In summary, the following report discusses several research domains that can be readily analytically integrated but are presented here as distinct sections of exploration. Section one provides an overview of the demography, geography, and hydrology of water in the Euphrates-Tigris Basin with an extended discussion of how climate change may be permanently changing the water landscape across the region. As the section points out, the (at best) semi-arid nature of hydrology across the region is already of major concern from an eco-systems standpoint. This is further complicated, as will be demonstrated, by increasing numbers in population and in increasing agricultural production which is water-intensive (cotton for example) when compared to other potential water end-uses across the region.

Section two provides an overview of the issues impacting water infrastructures, exemplified by the system of dams spread across Iraq and Syria. Dam infrastructure is important for two reasons. Dams are sources of stored water and sources of hydroelectric power production. Control over these structures translates into control over water and power that can be leveraged by the controlling party. The study also points out the value of a future ethnographic study of the region as part and parcel of a larger socio-economic analysis of the interaction of water and energy in the economic and human security environments of Iraq and Syria. This section spends considerable time and effort to discuss how water has played into ISIS activities to control the region and its people. However, this section avoids an extended discussion of how this group has specifically exploited these assets for its own end use, although this is acknowledged as important; the work of other scholars focused on this specific topic are highlighted for further research.

Section three seeks to help define the current state of electric power in both conflict-ridden states. The situation, as pointed out in Syria, is particularly dire. Based on recent sources cited, including a 2016 study by the International Monetary Fund (IMF) examining Syria's conflict economy,¹¹ and an assumption of aggressive pre-conflict growth rates, it could take Syria more than 20 years to recover to its pre-war level of GDP—central to which is its electricity sector as an economic engine of development. In Iraq, despite significant progress made since 2010 the country remains plagued by rolling electricity blackouts particularly outside the capitol of Bagdad. This is as much a fuel availability issue as it is an infrastructure one. It is further an issue critical to Iraq's future and its ability to provide electric power to the country's oil and gas industry (its largest industrial

¹⁰ Jennifer Ann Neuhauser, "U.S. Military Responsibility for Environmental Cleanup in Contingency Environments," *Environmental Law* 45, 1 (2015): 129-179.

¹¹ Jeanne Gobat and Kristina Kostial, *Syria's Conflict Economy, IMF Working Paper* (Washington: IMF, 2016).

consumer) concurrent to improving and providing increased electricity supply to the country's population.

Section four provides important lessons applicable to both water and energy infrastructure that can be learned from the Iraqi reconstruction period with a view towards improving on this approach in a future post-conflict Syria. Aside from the strategic implications and lessons learned from this study's undertaking is the equally important observation made by Collin Scott at the World Bank: "In MENA, like in any other region, peace and development are inextricably linked. There's no development without peace, and there's no peace without development. We're not arguing that development assistance is the difference between war and peace in the region – many of the causes of conflict are beyond the reach of development assistance – but we do believe development assistance has a contribution to make toward mitigating conflict risk."¹²

And finally to consolidate the position taken here that water, energy, and infrastructure security pay a peace dividend in a time of increasing insurgencies is the comment of Major General Peter Chiarelli, commander of the U.S. Army First Cavalry Division. Major Chiarelli notes analysis by his intelligence officers that the insurgency in Iraq was "strongest in areas with little or no sewer service, faltering electricity and high unemployment."¹³ He notes that environmental hazards caused by a lack of clean drinking water were particularly important to "'fence sitters,' who with the handover of sovereignty approaching [hadn't] decided whether or not they [would] support the new government or the insurgency."¹⁴ In short, whether it be the winding down of hostilities, the gearing up of post-conflict reconstruction, or a combination of both in parallel, there is a strong suggestion that both peace and development, if done correctly, cross-fertilize one another to the benefit of all concerned.

¹² Interview with Collin Scott and Caroline Bahnson, "Middle East and North Africa: Does Development Reduce the Risk of Conflict?," World Bank, February 1, 2012.

¹³ David E. Mosher et al., *Green Warriors: Army Environmental Considerations for Contingency Operations from Planning through Post-Conflict* (Santa Monica: Rand Corporation, 2008), 119.

¹⁴ Ibid.

Section One. Hydrology and Water Demand Growth in the Euphrates-Tigris Basin

The Euphrates-Tigris Basin is a transboundary river basin distributed across Iraq (46 percent), Turkey (22 percent), Iran (19 percent), Syria (11 percent), Saudi Arabia (1.9 percent), and Jordan (0.03 percent).¹⁵ Drawn from this basin, the countries of Iraq and Syria are the country focal points for this pilot project, which examines the treatment of this region's water and electric power systems, assets, and networks against the backdrop of over five years of civil war in Syria and conflicts that have raged for well over a decade in Iraq. Over and above the common conflict denominator these countries share is geography and similar hydrological and demographic challenges. This section focuses exclusively on the twin challenges of water and population. Other factors related to water and electric power that impact human security and state stability across the region will be addressed in separate sections of this paper.

Geographically both countries are considered part of the Mashriq sub-region of West Asia. This region ranges from the Mediterranean to semi-arid Iraq and Syria, with transboundary river systems. While much of this paper addresses the issue of drought both in hydrological and socio-economic terms, the combined Euphrates-Tigris Basin is subject to both drought and flooding. According to one source, "In Euphrates-Tigris River the rate of the flow changes from year to year. This situation is the main problem in the basin."¹⁶ As a result, in Iraq for example, "Such variations in annual discharge have caused large and possibly disastrous floods as well as periodic severe droughts. In the southern part of the country, immense areas are regularly inundated, levees often collapse, and villages and roads must be built on high embankments."¹⁷ Further, infrastructure construction such as dams and levees to protect people and property against flooding has provided a ready arsenal of water-related infrastructure that has been exploited by both governments and ISIS forces during ongoing conflicts in Iraq and Syria.

With or without a drought, the fact is that roughly 70 percent of the region receives less than 250mm of rain per year, and 83.3 percent of the region is considered water stressed.¹⁸ As a result, the (at best) semi-arid nature of hydrology across the region is already of major concern from an eco-systems standpoint. This is further complicated by increasing numbers in population and in increasing agricultural production that is water-intensive when compared to other potential water end-uses across the region.

¹⁵ Bernhard Lehner, Kristine Verdin, and Andy Jarvis, "New Global Hydrography Derived from Spaceborne Elevation Data," *Eos* 89, 10 (2008): 93-94, cited in Food and Agriculture Organization of the United Nations (FAO), *Irrigation in the Middle East Region in Figures, Aquastat Survey 2008*, Water Report 34 (Rome: FAO, 2009), 63.

¹⁶ Orsam, *Water Resources Management in Iraq*, Orsam Report No. 122 (Ankara: Orsam, 2012), 45.

¹⁷ Ibid.

¹⁸ United Nations Environment Programme (UNEP), *Global Environmental Outlook 3: Past, Present, and Future Perspectives* (London: Earthscan Publications Ltd., 2002), 173.

The map in Figure 1 clearly delineates Mesopotamia, the region found between and near the two rivers, encompassing eastern Syria and central and southern Iraq. The southern part of Mesopotamia sees less rainfall and higher summer heat gradient than the northern portion of the region.

Figure 1. Euphrates-Tigris River Basin



Source: BibleStudy.org

On the country scale, Syria receives, on average, less than 250mm of rainfall annually and is considered water scarce in assessments of water availability by several different research groups.¹⁹ The Food and Agriculture Organization of the United Nations (FAO) estimates that total renewable water availability in Syria, including renewable surface and ground water, is around 16.8km³ per year of which nearly 60 percent originates from outside of its borders.²⁰ In Iraq, 70 percent of the country receives on average 400mm of rainfall per year.²¹

For Iraq in particular, there are significant intrastate regional differences in water availability. The headwaters of both the Tigris and Euphrates are found in southeastern Turkey in the Anti-Taurus mountain region. The Tigris basin in particular geographically favors northern Iraq before flowing

¹⁹ See for example Malin Falkenmark, "Global Water Issues Confronting Humanity," *Journal of Peace Research* 27, 2 (1990): 177-190; and Paul Reig, Tien Shiao, and Francis Gassert, *Aqueduct Water Risk Framework* (Washington: World Resources Institute, 2013).

²⁰ Gleick 2014.

²¹ Aysegul Kibaroglu, *Building a Regime for the Waters of the Euphrates-Tigris River Basin* (Heidelberg: Springer, 2002), cited in FAO 2009, 63.

downstream to the southern part of the country where it joins with the Euphrates and ultimately empties into the Persian Gulf.²²

Iraq's average annual precipitation is estimated at 216mm,²³ and annual precipitation ranges from 1200mm in the northeast to less than 100mm in the south of the country. The mountainous region of northern Iraq gets more precipitation than the central and southern desert region.²⁴ The dilemma is that the normal cycle of precipitation in the region cannot sustain present requirements for irrigation in the basin. According to the Food and Agriculture Organization's report on the basin, "The typical low-water season in the Euphrates occurs from July to December, reaching its lowest point in August and September when water is most needed to irrigate the region's winter crops."²⁵ The report further notes that, "In the area close to the two river systems, rainfed farming is possible, although supplementary irrigation would raise yield and allow several cropping seasons. In the Mesopotamian Plain, however, the evaporative demand is very high and crops require intensive irrigation because of low annual rainfall and hot and dry summers."²⁶

Of particular hydro-political/policy interest is that 100 percent of the water in the Euphrates is of Turkish and Syrian origin from a greater to a lesser extent respectively. Therefore, while the majority of the surface area (compared to all other riparians) of both basins territorially lies in Iraq, Iraq contributes no water to the Euphrates and only 39 percent of the water to the Tigris. These geophysical facts underscore the importance of a transboundary conceptualization of the Euphrates-Tigris (ET) particularly in water management terms. Simply stated what happens upstream in terms of infrastructure development impacting on stream flow in Turkey has direct impact on downstream Syria and Iraq as riparians.

In the past, concerns over water have contributed to the threat of violent interstate conflict. As Jongerden notes, "A conflict did suddenly become a very real possibility in 1990, when Iraq and Syria thought Turkey had deliberately cut off their water supplies, as they simultaneously faced a serious decrease in water flow (the brewing conflict, however, was offset by another: Iraq's invasion of Kuwait). Today, the situation is heating up again. Iraq is suffering from serious water-supply shortages and locked in the deadly embrace of several armed organizations vying for power."²⁷ Concurrent with this have been Syria's own conflicts that have been intensified by a worsening water-supply context within the country itself.

²² FAO 2009, 63.

²³ FAO Electronic Files and Website, "Average precipitation in depth (mm per year)," *World Development Indicators* (Washington: World Bank, 2016).

²⁴ Orsam 2012, 57.

²⁵ Ali Akanda, Sarah Freeman, and Maria Placht, "The Tigris-Euphrates River Basin: Mediating a Path Towards Regional Water Stability," *Al Nakhlah* (Spring 2007), cited in FAO 2009, 67.

²⁶ FAO 2009, 67.

²⁷ Joost Jongerden, "Dams and Politics in Turkey: Utilizing Water, Developing Conflict," *Middle East Policy*, 17, 1 (2010): 137-143.

It is widely accepted that the global and regional scale water cycle has been changing since the last century due to the accumulation of anthropogenic greenhouse gases and changes in land use and land cover.²⁸ Climate change and variability were projected as far back as 2007 to have an ongoing and a devastatingly negative impact on Mesopotamia and the Fertile Crescent through the end of the 21st Century. On the basis of modeling moderate-to-severe climate change impacts, some scholars have concluded that as a result of the confluence of anthropogenically generated climate variability—longer cyclical periods of drought (e.g. reduced rainfall) and the loss of surface water as a result of higher heat indices through evapotranspiration—the cradle of modern civilization and the birthplace of modern agriculture will no longer be able to feed and water the region’s burgeoning population by the end of the 21st Century. The extent of this change creates a real probability that the Fertile Crescent will be fertile no more.²⁹ As the scientists report, “It is projected that, by the end of this century, the Fertile Crescent will lose its current shape and may disappear altogether. The annual discharge of the Euphrates River will decrease significantly (29-73 percent), as will the streamflow in the Jordan River. Thus countermeasures for water shortages will become much more difficult.”³⁰ These findings are supported by a 2014 study that details water discharge and stream flow from data assembled from 15 measuring points across the region.³¹

The reduced water availability in the combined ET basin is attributable to a number of complex, inter-related factors. Changing (and worsening) water supply across Syria and Iraq stems in part from the upstream development of hydropower and irrigation assets originating with Turkey’s Southeast Anatolia Project (*Güneydoğu Anadolu Projesi*, or GAP), which began in 1975 and has reduced downstream stream-flow to Syria and Iraq. Secondly, there are the noted impacts from increased greenhouse gas (GHG) emissions on the environment, leading to warmer summers particularly in Mesopotamia, higher rates of surface water evaporation across the region, and lower levels of precipitation. Third, effective countermeasures for water shortages have not been instigated on a transboundary basis.

There are many reasons why transnational countermeasures have not yet been developed. One reason is that these measures require universally acceptable data to serve as the basis for objective, transnational decision making on policies, procedures, and technologies to mitigate the negative impact that climate change and climate variability have on water availability. Yet there is no such agreed data. This lack of agreed data and an unwillingness to share data among the riparians has its own set of explanations. Among these are that potential reductions in downstream water flow

²⁸ Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. Susan Solomon et al. (Cambridge: Cambridge University Press, 2007).

²⁹ Akio Kitoh, Akiyo Yatagai, and Pinhas Alpert, “First Super-High-Resolution Model Projection that the Ancient ‘Fertile Crescent’ Will Disappear in This Century,” *Hydrological Research Letters* 2 (2008): 1-4.

³⁰ *Ibid.*, 1.

³¹ I. Elias Issa, Nadhir A. Al-Ansari, Govand Sherwani, and Sven Knutsson, “Expected Future of Water Resources within Tigris-Euphrates Rivers Basin, Iraq,” *Journal of Water Resource and Protection* 6 (2014): 421-432.

from Turkey into Syria and Iraq may not be as significant as these downstream states claim and/or reduced water availability in these states may stem from Iraqi and Syrian water mismanagement. A second reason why transnational countermeasures have not yet been developed is that there may be a lack of political will and/or financial resources in these countries to institutionalize more efficient water management practices. A third reason is that there may be a lack of willingness to cede agenda setting and control over water resources presently viewed as ‘national’ to a supra-national body.

In both Iraq and Syria, water scarcity and deteriorating water quality (due to increased salinity) result from not only from decreased stream flow but also from the introduction of upstream environmental water pollutants. Proper water management in this environment is impacted by:

- The absence of authoritative water institutions in the region with regional reach, which leads to poor water management and fragmented decision making,
- Lack of a universally agreed to dataset that would facilitate consensual decision making,
- Population growth and increasing urbanization,
- Political and military conflicts that negatively affect the development of the water sector,
- Escalating water demands, including water for irrigation driven by food self-sufficiency policies, and
- Lack of mechanisms for improving water regulations and enforcing these procedures.³²

Water Irrigation in the Euphrates-Tigris Basin

Numerous public policies from price subsidies to other incentives have contributed to the expansion of private agricultural output in the Euphrates-Tigris Basin. According to the FAO, output has been further increased by facilitating irrigation in areas traditionally dependent on rainfed farming. The FAO notes, “For example, the total irrigated area in Syria has nearly doubled over the past three decades, increasing from 625,000 ha (10.9 percent of arable land) in 1972 to 1,186 000 ha (25.2 percent of arable land) in 1999 (FAOSTAT 2001). In Iraq, the percentage of irrigated land increased from 30.3 percent in 1972 to 67.8 percent in 1999 (FAOSTAT 2001). Irrigation efficiency—the percentage of water that actually reaches the crop—does not exceed 50 percent in the region, and sometimes falls as low as 30 percent, leading to high water losses.”

Source: UNEP 2002, 174

Finally, there is the reality that agriculture and agricultural output has increased significantly over the past decades, as Iraq and Syria have sought to implement food self-sufficiency policies against the backdrop of significant population increases in these countries. Yet it is politically unappealing to alter or reduce the contribution that agriculture makes to national economic output—even against the stark reality of decreasing water availability. This is because agriculture is perceived as playing a key role in national economic and national security terms. It is particularly important to low- and middle-income families, employment, and subsistence farming. It is thus culturally

³² UNEP 2002, 175.

and economically challenging for those agricultural communities that have never known any other vocation and that may lack alternative skill sets to effectively restructure their entire (local) economies. This strands sectors of the population that have little alternative other than to migrate in search of other gainful employment.

By way of example, there are some in the scientific community who suggest that Syria's ongoing civil war was at a minimum influenced by the drought that has enveloped the region since 2006.³³ Wendle has written, "Drought, which is being exacerbated by climate change and bad government policies, has forced more than a million Syrian farmers to move to overcrowded cities. Water shortages, ruined land and corruption, they say, fomented revolution."³⁴

Wendle may have a point when one examines the growing importance of agriculture in the region over the past decades. As the UN notes, "The overall contribution of agriculture increased from 0.89 percent in 1975 to 4.22 per cent in 1998" for the Mashriq sub-region,³⁵ while overall water end-use in the Mashriq region attributable to agriculture was 80 percent.³⁶ This seems hardly a reasonable return on water investment in a water-scarce and water-stressed region but one that will have to improve, through science, adaptation, or import substitution, if the region is to survive.

The findings from Kitoh, Yatagai, and Alpert³⁷ raise two further issues hampering the ability of the ecosystem to meet the demand for water across the region. The first, and perhaps most significant, impact driving a growing demand for limited water resources is population growth across the entire Euphrates-Tigris region. Population is a key driver in the demand for natural resources and electric power, both which are focal points of this study. A baseline understanding of changes in population is fundamental to understanding stress trends in resource utilization. Of equal if not more importance in the short term than the size of a country's overall population is the rate at which the population is changing. An accelerating rate of population growth has key impacts on water and electricity demand.³⁸ Stress trends therefore have both a resource node—i.e. how much of a resource can be supplied over time—and a delivery node—i.e. the functional attributes that provide water access along with the ease of accessibility. Accelerating rates of growth in population stress both water resources and the ability of associated infrastructure to deliver it to points where needed. Where one, or both, are inadequate—regardless of the cause of the inadequacy—populations are negatively affected, which in turn threatens to catalyze human distress and suffering and—if not mitigated—may contribute ultimately to the death of affected

³³ See for example John Wendle, "The Ominous Story of Syria's Climate Refugees," *Scientific American*, December 17, 2015.

³⁴ *Ibid.*, no pagination.

³⁵ United Nations Economic and Social Commission for Western Asia (UNESCWA), *Survey of Economic and Social Developments in the ESCWA Region* (New York: UNESCWA, 1999), cited in UNEP 2002, 57.

³⁶ UNEP 2002, 173.

³⁷ Kitoh, Yatagai, and Alpert 2008.

³⁸ Kevin Rosner, *Energy Political-Economic, Governance Analysis of the Euphrates-Tigris Region (E-PEGA)* (Stockholm: Stockholm Environment Institute, 2014).

individuals or groups. Linear casual relationships between population growth, water availability, and political instability are less clearly understood but are intuitively interconnected.

On a regional basis, the high annual growth rate exceeding three percent per annum between 1950 and 2000 in the Mashriq sub-region substantially contributed to decreasing per capita share of water from from 6,057m³ in 1950³⁹ to 1,574m³ (2000).⁴⁰ UN population data reveals that the region's population increased from 37.3 million in 1972 to 97.7 million in 2000.⁴¹ This suggests that the large, regional increase in population is a main driver of diminishing availability of water across the region.

For Syria, the population has increased since the 1960s peaking in 2012 at approximately 22.5 million. Figure 2 shows the general population trend since 2006.⁴² The impact on the ongoing Syrian civil war on the nation's population has been significant falling by some 20 percent between 2012-2014. According to the UN High Commissioner for Refugees, as of June 2016, the number of refugees outside the country exceeded 4.8 million people with an additional 6.5 million Syrians internally displaced.⁴³ If and when these Syrians return to their home, this will place a considerable burden on already heavily debilitated or destroyed water resources, networks, and systems. Establishing a baseline in understanding the state of these resources and assets today is key to providing rapid, efficient, and cost-effective recovery for Syria's population after the current conflict ends. This is a key research challenge that can begin to be addressed now to support a future actionable item.

³⁹ J. Khouri, "Sustainable Management of Wadi Systems in the Arid and Semi-Arid Zones of the Arab Region," Paper presented at *International Conference on Wadi Hydrology*, Sharm El-Sheikh, Egypt, November 21-23, 2000, cited in UNEP 2002, 173.

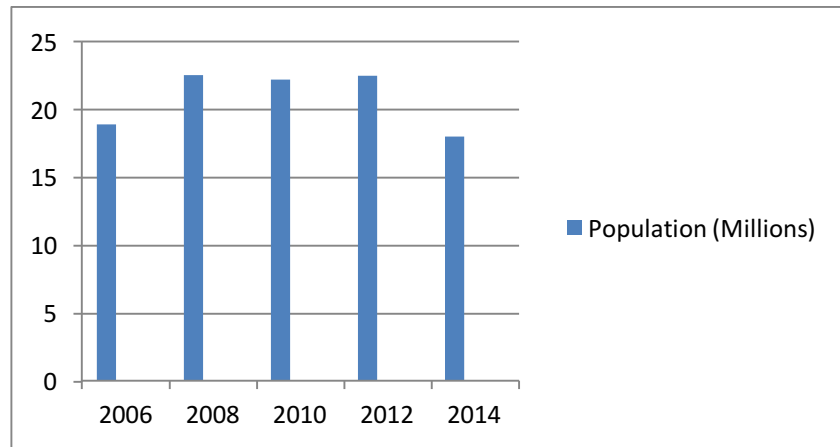
⁴⁰ UNEP 2002, 173.

⁴¹ United Nations Population Division, *World Population Prospects: The 2000 Revision, Volume III* (New York: United Nations, 2001), cited in UNEP 2002, 55-6.

⁴² *CIA World Factbook*, June 30, 2015.

⁴³ United Nations High Commissioner for Refugees (UNHCR), *3RP Regional Refugee and Resilience Plan 2016-17, Mid-Year Report* (Geneva: UNHCR, June 2016), 4. 9.

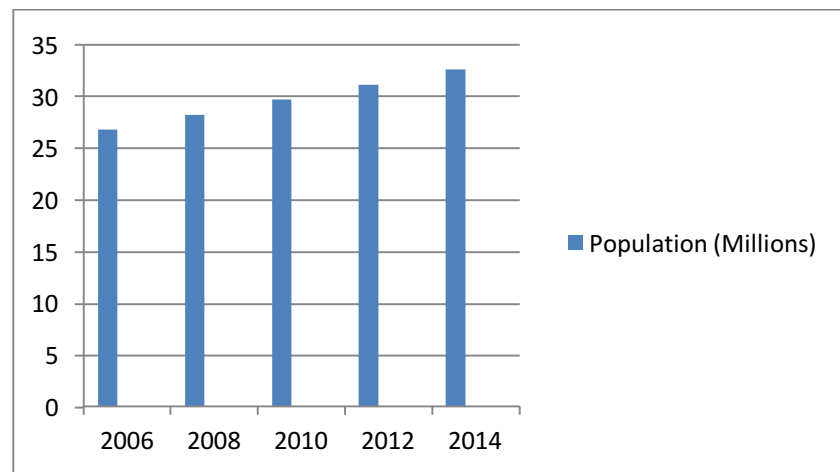
Figure 2. Syrian population (millions), 2006-2014



Source: Author compilation of data from CIA World Factbook⁴⁴

Iraq's average annual growth rate is approximately 3 percent. This rate of growth is prodigious (see Figure 3) given that the country has recently emerged from nearly a decade of conflict, has ongoing civil strife between segments of its population and with foreign insurgents, and faces many political, economic, and institutional challenges inherent in growing a modern state.

Figure 3. Iraqi population (millions), 2006-2014



Source: Author compilation of data from CIA World Factbook⁴⁵

⁴⁴ CIA World Factbook, June 30, 2015.

⁴⁵ CIA World Factbook, June 30, 2015.

The most important observation is that both countries have experienced growth in their national populations, which has placed growing demand on increasingly limited water resources. The dramatic war-related decrease in the Syrian population in the short term does not lessen Syria's water stress for the population that remains. Syrians have increasingly limited access to water resources given the destruction of water-related critical infrastructure, which is a different but equally critical water stress placed on the people.

Observations and Conclusions

A combination of complex hydrological and demographic factors are contributing to increasing water stress across the combined Euphrates-Tigris basins. These factors include climate changes that are rendering the region warmer in the summer season, particularly in southern Syria and south-central Iraq. Stream-flow from the Tigris—which originates in southeastern Turkey—has been impacted by the GAP dam infrastructure development and irrigation projects in Turkey that have downstream implications for Iraq. The circumstances, while not identical, are similar for the Euphrates, as its discharge waters are contributed to by both upstream Turkey and Syria riparians.

It is noted that anthropogenic GHG emissions have contributed to the region's increasing climate variability. Climate modeling capabilities, as in the Kitoh, Yatagai, and Alpert study, allow for improved predictive modeling at scale. Their study finding that the Fertile Crescent will be greatly diminished and perhaps even disappear this century holds both symbolic and actual implications for Syria and Iraq and the ET region on the whole.

Concurrent with disruptive climate variability—manifest in reduced amounts of precipitation resulting in longer and more severe periods of drought—has been significant increases in the populations in both Syria and Iraq. Growing populations and growing incomes due to increased economic expansion have been coupled with a growth in agricultural activity that now consumes approximately 80 percent of water used for all activities in Syria and Iraq. Against the backdrop of the significant conflict both Iraq and Syria have experienced over the past decade and half-decade respectively, and large segments of Syria's population lost to migration in the meantime, their ultimate return will place an increasing burden on already stressed and in many cases debilitated water resources and infrastructure. Preparing for this eventuality will be key to providing essential water resources, particularly to Syria's population on a humanitarian basis moving forward.

KEY RESEARCH TAKE AWAY

When Syrians return to their homeland, it will place a considerable burden on already heavily debilitated or destroyed water resources, networks, and systems. Establishing a baseline in understanding the state of these resources and assets today is key to rapid, efficient, and cost-effective recovery for Syria's population after the current conflict ends.

Section Two. Iraqi and Syrian Water, Conflict, and Fragility

“In the Middle East, water security is closely entwined with political stability, and it will become increasingly important to U.S. national interests.”

- Frederick Lorenz and Edward J. Erickson⁴⁶

The previous section of this study has outlined how water resources across the Euphrates-Tigris region, and particularly in Iraq and Syria, are increasingly stressed by both climate change and demographic change. Unlike the climatic aspects of water availability—e.g. how changes in precipitation impact the quantity of available water—which are beyond the control of human intervention, the infrastructures that store and exploit water for consumption and hydropower generation are well within the impact range of human action.

This section provides an overview of the variables impacting water infrastructures beyond environment, climate, and demographics as exemplified by the system of dams spread across Iraq and Syria. This section also provides an initial introduction of a proposed methodology that could be used to assess how demographic, ethnographic, and religious factors related to the human populations proximate to these structures impacts these structures. The region’s diverse ethnic, sectarian, and cultural groups discussed here provide examples of what could be explored in a far more specific study on the socio-economic context of water and electric power reconstruction in Iraq and Syria.

Water supply infrastructure includes everything “built to pump, divert, transport, store, treat, and deliver safe drinking water.”⁴⁷ Water infrastructure components include pumps, pipes, tanks, chemicals (such as chlorine use in water treatment), facilities used to house and store water, and dams used for water storage, irrigation, and power generation. Because of the irregular and less than comprehensive data on the state of much of non-dam water infrastructure under the conditions of the ongoing conflicts in Iraq and Syria, the focus of this section is on dams as examples of a tangible public water asset class. Other water-related assets—particularly water pump stations and treatment facilities—have suffered similar fates from ISIS attacks and control of areas with significant water infrastructure, particularly since 2014.

Dam infrastructure is important for two reasons. Dams are sources of stored water and hydroelectric power production. Control over these structures translates into control over water and power, which can be leveraged by the controlling party. Equally important as a future area of research exploration would be to catalog the location and physical state of water treatment facilities

⁴⁶ Frederick Lorenz and Edward J. Erickson, *Strategic Water: Iraq and Security Planning in the Euphrates-Tigris Basin* (Quantico: Marine Corps University Press, 2013), vii.

⁴⁷ Water Encyclopedia, www.waterencyclopedia.com/Hy-La/Infrastructure-Water-Supply.html.

and other critical nodes in both Syria's and Iraq's water infrastructure, as these facilities are directly linked to the human security of the populations they service.

The reason for a socio-economic analysis of water in these countries is also direct and straightforward. In the past, access to resources, at least in Iraq, has been determined in part by the ethno-religious composition of the end-user group. The 2006 Iraq Study Group report noted:

First, the government sometimes provides services on a sectarian basis. For example, in one Sunni neighborhood of Shia-governed Baghdad, there is less than two hours of electricity each day and trash piles are waist-high. One American official told us that Baghdad is run like a "Shia dictatorship" because Sunnis boycotted provincial elections in 2005, and therefore are not represented in local government.⁴⁸

Further, as the percentage of IDPs, particularly in Syria, has grown overtime these populations are increasingly likely to have poor water services and be exposed to health risks associated with unstable or poor water quality regardless of their socio-economic or ethno-religious affiliations.

Similar ethno-religious discrimination in water access is seen in Syria. It is a clear policy of the Syrian government and its Russian ally, as it is for other belligerents to this conflict, that to deprive ethno-religious adversaries basic fundamental water resources has become a tactic of war. The targeting and or use of water resources under the conditions of conflict represents a "rebirth" of weaponizing water as Tobias von Lossow has written.⁴⁹

The fact is that a right to water is not explicitly stated but is implicit both in the UN Charter and the 1948 Universal Declaration on Human Rights. Article 55 of the UN Charter promotes, "universal respect for, and observance of, human rights and fundamental freedoms for all without distinction as to race, sex, language, or religion."⁵⁰ Article 25 of the Declaration states, "[e]veryone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services."⁵¹ Having access to water of sufficient quantity and quality would be covered under this article.⁵²

In the face of ongoing conflicts in Iraq and Syria, these rights have been routinely violated by all parties to the conflicts. Perhaps more importantly to be avoided in the future, if the Iraqi and Syrian governments are to reach peaceful co-existence with their ethically and culturally heterogeneous

⁴⁸ James A. Baker, III et al., *Iraq Study Group Report* (New York: Vintage Books, 2006), 20.

⁴⁹ Tobias von Lossow, *Water as Weapon: IS on the Euphrates and Tigris, The Systematic Instrumentalisation of Water Entails Conflicting IS Objectives* (Berlin: German Institute for International and Security Affairs, 2016).

⁵⁰ United Nations, *Charter of the United Nations* (San Francisco: United Nations, 1945), Chapter IX, Article 55.

⁵¹ United Nations General Assembly, *Universal Declaration on Human Rights* (Paris: United Nations, 1948), Article 25.

⁵² John Scanlon, Angela Cassar, and Noemi Nemes, *Water as a Human Right?* (Gland: International Union for Conservation of Nature and Natural Resources, 2004).

populations, is to ensure that violations based on “race, sex, language or religion”⁵³ (1) are not allowed to reoccur and (2) are avoided by the establishment of non-discriminatory access to water resources in a post-reconstruction era. The theoretical and practical underpinnings of such a corrective and palliative policy response to this issue will be elaborated in the final section of this study. One way to achieve such an egalitarian future in the water sphere is to use a mapping process that overlays basic water infrastructure with socio-economic, political, and ethno-religious depictions of the end-user populations. This mapping should be done at the most granular level possible to allow for highly targeted water-related interventions. A potential approach to such a process is discussed at the end of this paper.

The human and infrastructure costs of conflict involving water infrastructure complicate an already difficult humanitarian situation. One concern is the increased risk associated with reliance on poorer-quality water sources, more distant water sources, or less-preferred water delivery systems. Reliance on poorer-quality water can put households at risk of disease. Reliance on more distant water sources can put users at greater risk of violence or physical harm. The further end users in a conflict region are from a water source, the more at risk they become to violence or physical harm as they venture to retrieve this resource, especially if these alternate sources have become public gathering areas or are otherwise in exposed locations. Reliance on delivery mechanisms like boreholes also poses risks, as boreholes have become increasingly susceptible to higher degrees of water salinity, which has its own health consequences.

Another concern is how conflict impacts the consistency of access to water. In regions experiencing conflict, the financial cost of water may vary depending on the ability of municipal authorities to collect payment for water. Water cost may also be a function of how the pre-conflict cost for water itself was determined, which in some cases may have been free. It is important to note this dilemma, as in Iraq over the last ten years, the availability, reliability, and quality of delivered water was at least in part a function of the security situation surrounding the location of critical nodes such as treatment plants or pump stations. In an area where control over water resources is considered chattel of war and control of these resources is fluid, the availability, reliability, and quality of delivered water may fluctuate dramatically. Crews dispatched to repair water services have often been targeted by parties seeking to deprive recipients of these resources for military or conflict-related purposes. The human and financial cost for these water services can thus increase exponentially as security services often must be procured to protect these individuals. The conflict-related dimensions of water can thus eclipse the state of the water infrastructure itself as a key determinant of water availability, reliability, and quality.

⁵³ UN General Assembly 1948.

ISIS, Water, and Territory in Perspective

This study will provide a brief case example of ISIS and the Tabqa Dam in Syria to deconstruct the significance of asset seizures by ISIS, focusing on both its symbolic and actual impact on food, water, and energy in the region. But before doing so, this section seeks to address the larger unanswered question as to how ISIS itself views the territorial boundaries of its proto-state and why this consideration is important. Addressing this question helps put into perspective ISIS actions vis-à-vis water in Syria and Iraq.

An understanding of the role of territory for ISIS is critical to arriving at a balanced understanding of the competing roles of history, ideology, and greed in ISIS' seizure of water and other natural resource assets for the purpose of state-building.

In 2014, after ISIS' seizure of large amounts of territory across northern Syria and Iraq, an ISIS spokesman Abu Mohammed Al-Adnani loosely defined the state territory as running from northern Syria to the Iraqi province of Diyala—a vast stretch of land straddling the border that was already largely under ISIS control.⁵⁴ More specifically, “[f]ighters loyal to the group’s proclaimed ‘Caliph Ibrahim ibn Awwad,’ or Abu Bakr al-Baghdadi as he was known...are inspired by the Rashidun caliphate, which succeeded the Prophet Muhammad in the seventh century, and is revered by most Muslims.”⁵⁵ If this interpretation is accurate, then ISIS’ expansion plan into Iraq, Syria, westward into Egypt and beyond, and eastward into Iran follows the historic development of Islam’s first caliphate.⁵⁶ This suggests that ISIS scoped out a general region based on historical precedent that also conveniently corresponded to the area where it was already present in a civil war-torn Syria and the fragile state of Iraq. Its movements are explained by the dominant desire to control territory and not necessarily by those assets, i.e. water and electric power, found across conquered landscape.

The greater importance of territory however is that, once conquered and identified by ISIS as part of its caliphate, that territory must be defended by ISIS at all costs, as the holding of territory defines the caliphate’s geographic space and political authority.⁵⁷ It is therefore the need for territorial expansion, and not a singular focus on the seizure of water assets in particular, that helps explain how and why water assets fell into the hands of ISIS. The impact of conquest is that all assets found within the boundaries of territory ISIS controls revert to it for exploitation by the proto-state. This is seen not only with ISIS’ exploitation of water assets, but also most dramatically

⁵⁴ John Hall, “The ISIS Map of the World: Militants Outline Chilling Five-Year Plan for Global Domination as they Declare Formation of Caliphate - and Change Their Name to the Islamic State,” *Daily Mail*, June 30, 2014.

⁵⁵ Michel Chossudovsky, “The Islamic State (ISIS), the ‘Caliphate Project’ and the ‘Global War on Terrorism,’” *Global Research*, July 2014.

⁵⁶ “Rashidun Caliphs,” Encyclopaedia Britannica, www.britannica.com/topic/Rashidun.

⁵⁷ See for example Zack Beauchamp, “ISIS, A History: How the World’s Worst Terror Group Came to Be,” *Vox News*, November 19, 2015.

in its seizure and trafficking of people, as well as the seizure, sale, and in some case destruction of antiquities, and in the illegal sale and taxation of oil in both Iraq and Syria.

An understanding of how this radical jihadist movement or future manifestations of it may view the physical conceptualization of its caliphate may help to anticipate its future movements. Identification of assets that could be exploited in the areas it may move into and ultimately control may catalyze a rethink of what to protect and what not to protect in confronting this or other adversaries prone to similar behavior. This paper concludes that far too few actions have been taken to identify and protect assets and infrastructure that ISIS could target and use to its advantage. The advantages these resources have given ISIS during the conflict, and the difficulty their destruction presents for reconstruction after the conflict, are core challenges that can be assessed now to plan future responses.

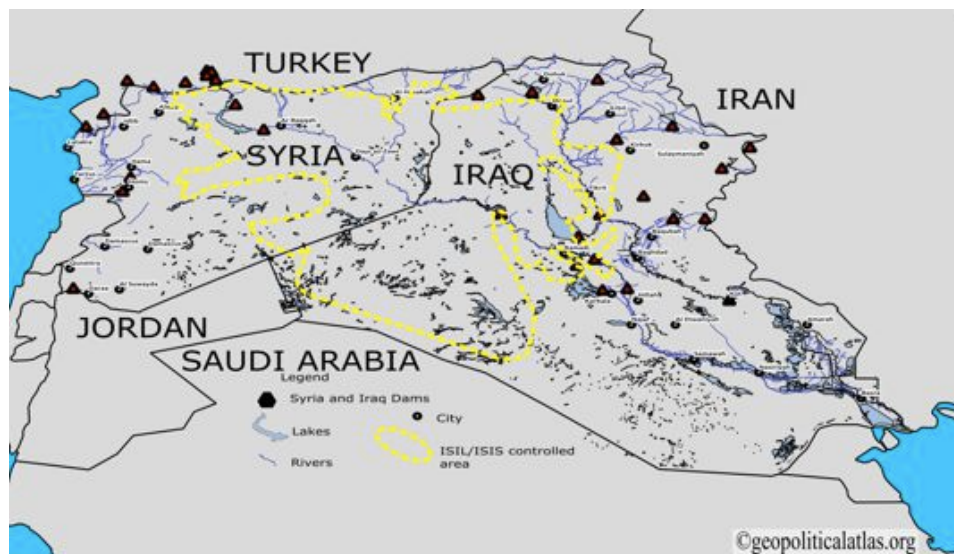
The loose configuration of the ISIS caliphate does not diminish the important contributing role of water, energy, and commodity resources to its ability to wage war. It does however diminish, as an order of magnitude, the focus on natural resources and their exploitation as a jihadist activity. In short, water and energy resources—both in their raw form and in their ability to generate revenue for the group controlling them—may be considered spoils of war with obvious and observed significant long-term consequences if jihadist groups control them. The conflict in Iraq and Syria is fundamentally then, at its core, not a conflict driven by resources but a conflict driven by territorial expansion and governed by ISIS’ radical, jihadist interpretation of Islamic law. Resource access and exploitation therefore are a means to the larger goal of territorial control and defensive maintenance of that territory. Having said this, Figure 4 below provides a snapshot of ISIS controlled territories in Iraq and Syria (in 2015) and the group’s proximity to water and water infrastructure in Iraq and Syria. Of course this map has changed considerably over time but does provide an illustration emblematic of how this insurgency’s movements have coincided with these assets in the region.

Further it has been noted by the *New York Times*, that “[t]he Islamic State has [had] contested or controlled many towns along the Euphrates River since as early as January 2014.”⁵⁸ A focus on water resources alone could lead one easily to conclude that its land grab across Iraq and Syria was principally water focused and even water-resource driven. But closer examination reveals that the Euphrates, which traverses both Syria and Iraq, primarily provides a corridor that ties these territories together for the ease of logistics and the unencumbered movement of foreign fighters across these porous borders. Again the exploitative benefits of controlling the associated water infrastructure along the Euphrates in Syria and Iraq, and ISIS’ attempts to seize and control the Mosul dam (which was ultimately thwarted by Iraq and coalition partners), are more territorially and militarily driven than resource driven.

⁵⁸ Sarah Almukhtar, Tim Wallace, and Derek Watkins, “ISIS Has Lost Many of the Key Places It Once Controlled,” *New York Times*, July 3, 2016.

Some have alleged that water stress catalyzed Syria's civil war, asserting that drought related to climate change exacerbated the plight of Syria's farmers and caused many of them to migrate to Damascus and other cities across Syria.⁵⁹ But equally significant may be the impact that decades of water mismanagement and agricultural mis-calculation had on Syria's water catastrophe. Syria's civil war was preceded by decades of changing agricultural and economic policies that encouraged production of crops like cotton that are highly water intensive while its hydrology was evolving towards drought-like conditions.⁶⁰

Figure 4. Syria and Iraq water resources and dams



Source: Goldkorn 2015a⁶¹

Some have even argued that the emergence of ISIS as a significant intrastate insurgency may have been fueled by deprivation across both Syria and Iraq and contributed people to ISIS' fighting force.⁶² Yet this interpretation does not help to answer the large and lingering question regarding the relationship—if any—between conflict and natural resources. If we accept the interpretation that ISIS—in pursuit of the establishment of its caliphate—prioritized conventional land grabs, albeit through unconventional means, over the pursuit of water, electrical power, and other portable resources like oil, then we are no further ahead in understanding the relationship between

⁵⁹ Henry Fountain, "Researchers Link Syrian Conflict to a Drought Made Worse by Climate Change," *New York Times*, March 2, 2015.

⁶⁰ IRIN, "Why The Water Shortages?," *IRIN News*, March 25, 2010. See also Raymond Hinnebusch, Atieh El Hindi, Mounzer Khaddam, and Myriam Ababsa, "Agriculture and Reform in Syria," *Syria Studies* 3, 1 (2011).

⁶¹ Giacomo Goldkorn, "Syria and Iraq Water Resources and Dams," *GeopoliticalAtlas.org*, February 22, 2015. Sources for data used in map are www.diva-gis.org/gdata, www.mapcruzin.com/free-iraq-arcgis-maps-shapefiles.htm, and www.fao.org/nr/water/aquastat/dams/index.stm.

⁶² See for example Ömer Taşpınar, "ISIS Recruitment and the Frustrated Achiever," *Huffington Post*, March 25, 2015.

conflict and natural resources. What can be observed however is the use of these resources for militarily strategic and tactical purposes in the modern era.

The outbreak of modern conflict in the basin after the 1960s reflects two concurrent developments noted earlier in this paper. These are the accelerating rate of population growth in both Iraq and Syria, coupled with an acceleration in water infrastructure development that nonetheless failed to keep pace with population growth. One researcher describes it as follows:

Conflict began as early as the 1960s, where population pressures led each of these countries to unilaterally pursue development of water resources. By 1974, Syria's Tabqa Dam ha[d] deeply affected Iraq's water supplies, falling from 920m³/s, to an 'intolerable' 197m³/s, such that Iraq called for Arab League intervention.⁶³ By 1975, troops had amassed at the borders, but Saudi Arabian intervention brokered an agreement thought to permit Syria to keep 40 percent of its reserves, with 60 percent flowing through to Iraq.⁶⁴

After the launch of the Turkish GAP project in 1975, things gradually worsened for downstream Iraq and Syria. As Turkish authorities began to complete their infrastructure projects and in doing so store upstream water, the overall effect—at least by one estimation—has been that, “as of the summer of 2012, the GAP had already reduced water flows into Syria by 40 percent, and into Iraq by 80 percent.”⁶⁵ Since the end of the second Iraq war and the outbreak of civil war in Syria, considerable effort has gone into cataloging conflicts perceived to be over water issues like reduced stream-flow and worsening water quality.⁶⁶ But against the landscape of continuing conflict in both countries, it is admittedly hard to keep pace in cataloging all of these events. Marcus King's work in creating a had topology of modern water-related conflict events in Iraq and Syria is an important contribution in this regard.⁶⁷

Iraq and Syria Water Fragility

Conflicts relevant to the state of water resources and infrastructure in Iraq and Syria did not start with recent events. Instead, they have flared up under different circumstances over time. Events that catalyzed these events range from civil disputes to outright war. As the U.S. Department of State outlined in its Future of Iraq Project, Iraq's water infrastructure was already in a debilitated

⁶³ Aaron T. Wolf, *Middle East Water Conflicts and Directions for Conflict Resolution* (Washington: International Food Policy Research Institute, 1996).

⁶⁴ Saira Kahn, *The Islamic State's Management of Water Infrastructure in Iraq and Syria*, unpublished manuscript, Dayan University Tel Aviv University, October 2015, 4.

⁶⁵ *Water-Shortage Crisis Escalating in the Tigris-Euphrates Basin* (West Perth: Future Directions International, 2012), cited in Kahn 2015, 4.

⁶⁶ See for example Raymond Hinnebusch, Atieh El Hindi, Mounzer Khaddam, and Myriam Ababsa, “Agriculture and Reform in Syria,” *Syria Studies* 3, 1 (2011).

⁶⁷ Marcus DuBois King, “The Weaponization of Water in Syria and Iraq,” *Washington Quarterly* 38, 4 (2016): 153-169.

state well in advance of the second Iraq war.⁶⁸ After Iraq's invasion of Kuwait in 1991, and the subsequent damage inflicted on Iraq's infrastructure during the Persian Gulf war between Iraq and the global coalition of 34 nations that opposed the invasion, circumstances worsened with the imposition of global sanctions on the country in the form of embargos. This situation began to be corrected with the 1995 UN Oil for Food program but by that time significant damage had already been done. As the State Department report outlined, from 1990 to 1999 the water sector in Iraq exhibited the following characteristics:

- Decrease in the quantity of water supply by more than 50 percent,
- Six-fold increase in water contamination,
- Deterioration of raw water quality due to untreated sewage disposal and drought effects,
- More than a 90 percent cut in government budget allocations to cover local expenses,
- More than a 40 percent cut in personnel resulting in a loss of experience,
- Water losses through the deteriorating network increased from 15 to 35 percent, and
- Frequent power cuts interrupting the system of up to 10 hours a day.

The effects of the second Iraq war on Iraq's overall infrastructure had decidedly negative effects on the quantity and quality of functioning infrastructure stretching across both water and electric power domains, which are addressed in the concluding section of this paper.

In Syria, damage to pumping stations and other water infrastructure has been severe, especially in areas that witnessed high levels of violence such as rural Damascus, Idlib, Deir E-Zour, Homs, Aleppo, and Raqqa. The situation is worsened by frequent power cuts, fuel shortages, and lack of maintenance of pipes and water works. Many water utilities are short of chlorine needed to treat water, and trucked water that many communities rely on is of poor quality.

Specifically, a (now-dated) UNICEF report on Syria from 2013 noted that:

- In areas that had experienced conflict, the availability of potable water had been reduced by a third from pre-crisis levels of 75 liters to 25 liters per day. Water pumping had decreased substantially in some areas. For example, in places like Deir Ez-Zor, it dropped by up to 90 percent, while in Damascus it was reported to have fallen by 20 percent. This was more likely than not due to disruptions in the flow of electric power on which these pumps depend.
- Urban water supply networks are particularly vulnerable to attacks and system failures, depending on their distance from city centers.

⁶⁸ U.S. Department of State, *The Future of Iraq Project, Economy and Infrastructure (Public Finance) Working Group* (Washington: U.S. Department of State, Released 2005).

- Transporting water by truck is commonly used in communities where water networks are not functional but the cost of this water is often beyond the financial means of most families.⁶⁹

Finally select observations from a 2015 household assessment on water security in Syria's (formerly) largest city of Aleppo provide a more granular view to the challenges and hardships of rebel-controlled neighborhoods in the eastern part of this city.⁷⁰ In summary, this assessment reports that:

- “The water supply has been used as an instrument of war by all parties to the conflict. For two weeks in April and May 2014, Aleppo’s sole remaining pumping station, Suleiman al-Halabi, was deliberately disabled, forcing 200,000 to 300,000 residents on both sides of the frontline to collect water from contaminated wells, public fountains, rivers, and storm drains.”⁷¹
- “As of March 2015, less than half (42%) of eastern Aleppo residents obtained their drinking water primarily from the municipal network via in-home pipelines, compared to 62% in May 2014 and a near-universal 94% before the start of the conflict.”⁷²
- “A single water source often proved insufficient to meet all of a household’s needs. For example, 42% of eastern Aleppo residents used in-home pipelines as their primary source of drinking water; however, only 26% of respondents could rely on these pipelines for both drinking water and for the additional water they needed for domestic use.”⁷³
- “Due to the dangerous security context and the widespread destruction of infrastructure, no water source in eastern Aleppo can be considered consistently adequate or reliable.”⁷⁴
- “The municipal network is heavily damaged and vulnerable to appropriation as a military target; well and borehole water tends to be saline and improperly purified; private water tankers are sometimes contaminated by waste water and can spread disease; humanitarian access is inconsistent.”⁷⁵
- “The fact that a household primarily relies on a “free” water source does not necessarily imply that it does not pay for water. Outside of Aleppo, this is particularly true of ISIS-controlled areas.”⁷⁶
- “On average, water was the fifth-largest expenditure category for eastern Aleppo households, following food, fuel, and electricity.”⁷⁷

⁶⁹ United Nations International Children’s Emergency Fund (UNICEF), *Running Dry: Water and Sanitation Crisis Threatens Syria’s Children* (Amman: UNICEF, 2013), 1.

⁷⁰ REACH, *Eastern Aleppo Household Assessment: Water Security* (Geneva: REACH, 2015).

⁷¹ *Ibid.*, 2.

⁷² *Ibid.*, 4.

⁷³ *Ibid.*, 5.

⁷⁴ *Ibid.*, 5.

⁷⁵ *Ibid.*, 5.

⁷⁶ *Ibid.*, 6.

⁷⁷ *Ibid.*, 7.

- “30 days prior to the March 2015 data collection for this report, nearly two-thirds (66%) of eastern Aleppo residents faced difficulties accessing drinking water. A similar number, 62%, had problems accessing water for household purposes. Households with internally displaced people (IDPs) faced more frequent issues obtaining both types of water.”⁷⁸

A June 2016 assessment of Syria’s conflict economy summarizes damage suffered by this country’s infrastructure as follows:

The water sector has suffered significant damage. There were 260 water sector assets ranging from water tanks, treatment facilities, and dams. Of those, about one-quarter, predominantly the water towers, have suffered damage. Those in Aleppo and Dar’a suffered the most damage. Also, reduced functionality is a significant problem. Water infrastructure’s dependence on electricity infrastructure has impacted service delivery. That is particularly so for Aleppo, where the Tishreen Dam, which provided 60 percent of Aleppo’s power, has reduced the operational times of pumping stations, and limited household access to both clean water and electricity. In addition, population shifts due to the influx of internally displaced persons in relatively conflict free areas (such as Latakia) have placed additional stress on public infrastructure.⁷⁹

Without further survey research it is hard to conclude the extent to which the state of the water sector and water infrastructure in Aleppo holds true for the rest of the country outside government-controlled or government-aligned areas. Gobat and Kostial with the IMF/World Bank estimate put the destruction of water infrastructure at 40 percent of all the destruction in the country’s six major cities monitored.⁸⁰ What is clear is that the consistency in the debilitation and destruction of water and its related infrastructure is widespread and, in some areas like Aleppo, acute. It is therefore a need to develop a triage methodology for moving into water-and ultimately electricity-deprived areas. Fulfillment of this need is not only appropriate for Syria but for Iraq as ISIS is increasingly pushed back.

Tabqa Dam Case Example

The Tabqa dam is also known as the al-Thawra dam, in Arabic *سد الثورة*, meaning *dam of the revolution*. It was designed to control the flow of the Euphrates river into Iraq and Syria, produce hydroelectric power, and irrigate land along of the river. Its completion in 1973 effectively created Lake Assad and gave Syria its largest dam.

⁷⁸ Ibid.

⁷⁹ Gobat and Kostial 2016, 21.

⁸⁰ Ibid., 21.

The dam is located within 25 miles of the city of Raqqa, the operational center and the de-facto capital of ISIS. ISIS took complete control of Raqqa in January 2014. It was the first major city to fall under the group's control, thereby starting its state-building efforts on a large scale. The provision of basic services included water, as evident in leaked administrative documents that outline ISIS' principles for governing conquered territory and becoming a viable state,⁸¹ dubbed the "ISIS papers."

As ISIS ramped up its activities in 2014, the seizure of these assets provides a number of lessons for appreciating the multiple and cascading impacts of water and water-asset seizure in Syria and Iraq. First, the Euphrates is the main source of drinking water for Raqqa on which the Tabqa dam is constructed. The dam itself is used for irrigation and hydroelectric purposes, as detailed in this study's Annex on Dams in Iraq and Syria. According to reporting carried out in 2014, "The water level of Al-Assad Lake—Syria's largest reservoir, which provides irrigation for some 500 square miles of agricultural land and all of Aleppo's drinking water—has dropped by six meters since ISIS took control of that area in January 2014. If the lake loses one more meter, the water system will stop working. This will leave more than four million inhabitants without access to safe water. This could result in a humanitarian catastrophe that would overwhelm agencies on the ground."⁸² In addition, media report that "two of Raqqa's most important water facilities are located along its south bank...[these are] a pumping station...and a purification plant.... There are also several water infiltration wells...on both sides of the river. These are shallow wells which put or draw water into a natural aquifer outside the Euphrates' riverbed."⁸³

Over the past two years, ISIS' seizure of the Tabqa dam (back) from Syrian rebels (who had overrun ISIS' territory in 2013) has allowed ISIS to exercise control over its de-facto capital Raqqa. Control of the dam has allowed it to set up a system of tax-and-spend activities using seized water assets and the hydropower it generates as a quid-pro-quo state asset. More recently, it was reported in January 2016 that the group was holding high-value prisoners and using the dam as shelter to ward off airstrikes.⁸⁴ The impact of a dam breach or destruction, "would devastate much of Iraq and Syria if it was ruptured."⁸⁵ This potential has led Russia at least as of this writing to abstain from using its air power to attack these forces embedded directly at the site of the dam. Slightly further afield in and around the city of Tabqa itself, fighting was reported in June 2016 between Syrian Army and ISIS forces.⁸⁶ In addition to the dam, Tabqa also houses a nearby former

⁸¹ Aymenn Jawad Al-Tamimi, "Archive of Islamic State Administrative Documents," Aymenn Jawad Al-Tamimi's Blog on *Pundicity*, January 27, 2015.

⁸² Sarah Goodyear, "Using Water as a Weapon of War," *Next City*, July 21, 2014.

⁸³ Christian Triebert, "Keeping the Water Running in the Islamic State," *Bellingcat.com*, April 14, 2016.

⁸⁴ Damian Paletta, "Islamic State Uses Syria's Biggest Dam as Refuge and Potential Weapon," *Wall Street Journal*, January 20, 2016.

⁸⁵ Simon Tomlinson, "Bomb Us If You Dare: Senior ISIS Militants Are Holed Up Inside Syria's Largest Dam with High-Value Prisoners Knowing Air Strikes Would Unleash Apocalyptic Flood," *Daily Mail*, January 22, 2016.

⁸⁶ Rudaw, "Syrian Regime Fends Off ISIS Attack in Raqqa Province," *Rudaw News Service*, June 14, 2016.

Syrian airbase effectively giving the city conventional military significance for housing assets, as well as unconventional military significance given the use of water assets in both Iraq and Syria.

Another insight into the state and management of the Tabqa dam and its associated water facilities is the apparent arrangement between ISIS and the Assad regime in managing Tabqa water facilities. It has been reported that an uneasy relationship between the two allows water service delivery to continue under the management of former Assad regime engineers and experts who continue to be paid by the Assad regime while ISIS recovers taxable income from the use of this water from members of the besieged population.⁸⁷ If true, this reflects a similar practice that until recently ran in Iraq, as reported by the *New York Times* in April 2016, whereby “American officials prevailed upon the Iraqi government to finally stop paying salaries to its officials and workers who live in areas controlled by the Islamic State. The payments totaled about \$170 million a year, American officials said, and the Islamic State skimmed off about 10 percent or more of each paycheck in taxes.”⁸⁸

Helping to systematize the analysis of how water has been used in Iraq and Syria, as exemplified in this case by the Tabqa dam, is the work of Marcus King. The Tabqa dam incident appears to fulfill King’s definition of the strategic weaponization of water. King writes: “The first [type of strategic weaponization] is the use of water to virtually or actually control large or important land areas or facilities to fulfill the vision of sovereignty, and the second is as an asset to fund activities, such as administration and weapons acquisition, of a ‘state.’”⁸⁹ Clearly case of the Tabqa dam meets the criteria for both of these interpretations associated with ISIS’ mimicking of the ownership, tax, and spend activities of a modern state. In doing so, it demonstrates how the use and control of water in this conflict zone eclipses water’s fundamental biophysical contribution to sustaining life.

In summary, the Tabqa dam seizure thus illustrates the following:

- *Political symbolism:* A significant demonstration of ISIS territorial control and establishment of its self-proclaimed caliphate in the region that includes its de-facto capitol Raqqa,
- *Infrastructure asset:* A significant asset seizure of enormous importance, as the dam is the largest hydroelectric facility in Syria, providing water for irrigation that links directly to the provision or denial of water for agricultural purposes and thus linking directly to water and food security,
- *Governance and nation building:* A demonstration of ISIS ability to seize and control assets for the purpose of taxation and therefore revenue generation,

⁸⁷ Paletta 2016.

⁸⁸ Matthew Rosenberg, Helene Cooper, and Nicholas Kulish, “ISIS Expands Reach Despite Military and Financial Setbacks, *New York Times*, April 12, 2016.

⁸⁹ King 2016, 156.

- *Geopolitical leverage*: A demonstration of its power to co-opt the Syrian government in working with it to literally keep the lights on in the dam's service area, and
- *Militarization and weaponization of natural resources*: The ability to exploit water and water infrastructure for strategic and tactical military purposes.

The Tabqa dam is by no means the only facility under ISIS control across Syria and Iraq, but it is among the more important facilities for the exercise of regional control. Given the Tabqa experience, ISIS moves to seize control over the Mosul dam in Iraqi Kurdistan—with Mosul being the Iraqi equivalent of Syria's Tabqa dam—were quickly repulsed in part with the assistance of U.S. airstrikes and Kurdish ground forces. Other critical dam facilities near ISIS forces or in areas of ISIS control have been chronicled by Tobias von Lossow⁹⁰

Socio-economic Context of Water and Energy in Iraq and Syria

The socio-economic context of water and energy in Iraq and Syria presents a continuously changing network of impact and impacted stakeholders. These include ethnic, religious, political, cultural, and economically diverse groups found with the general populations found in both states. The socio-economic challenges these countries face are enormous and are growing as new conflicts emerge and new combinations of allied and conflicted partners group and re-group among themselves. What needs to be focused on moving forward is not the religious, ethnic, and cultural construction of the Iraqi and Syrian populations per se but the significance of being able to geolocate groups, both allied and competing, proximate to water and energy infrastructure in these two states.

As the hydrology section of this study points out, water paucity due to climate variability could potentially lead to the irreversible absence of water in the Fertile Crescent will force people on the move. Already under the conflict conditions in both states, it is certain that all groups, regardless of ethno-religious, social, or political affiliation, have been negatively impacted by reduced access to or denial of resources fundamental to human security (i.e. water) and the functioning of a modern state (i.e. electric power). Yet the ethno-religious, socio-economic, and political distinctions among and between sub-groups provide the working context within which these network systems must operate. As the concluding chapter of this study addresses, the numerous differences among and between the Iraqi population (as one example) have played a significant role in preventing the repair of essential, debilitated water and energy infrastructure. Maintenance personnel in the water sector in Iraq have come under physical attack by adversaries of the potential recipients of repaired infrastructure, making their repair both physically dangerous and exceedingly expensive to repair.⁹¹

⁹⁰ Tobias Von Lossow, *Water as Weapon: IS on the Euphrates and Tigris, The Systematic Instrumentalisation of Water Entails Conflicting IS Objectives* (Berlin: German Institute for International and Security Affairs, 2016).

⁹¹ SIGIR 2009

The Working Context

Understanding the ethno-religious, socio-economic, and political variables of water and energy access and deniability is foremost an exploration to be undertaken by the social science community. The findings of such a study, however, are relevant to the multi-disciplinary community of interests that surround water, electric power, and natural resources across this region. Beneficiary communities of such an analysis range from the engineering community that will assist in the land-use, planning, and reconstruction of water and electric power systems to the security specialists charged with identifying, pinpointing, and explaining how resource access disruption, destruction, and ultimate deniability may contribute to social and civil unrest.

Pinning down the social, demographic, and ethno-religious dynamics of these societies—and in particular how the governed have been under-represented among those who govern them—is a first step in appreciating this region’s complexity. The socio-economic and ethno-religious data described here are simply intended as concrete examples, if nothing more, to catalyze the discovery process fundamental to answering some of the more complex questions that arise from even a cursory examination of the region’s rich diversity of people and history.

Finally as pointed out earlier, there are several continuously changing issues, like unpredictable climate conditions and increasingly complex social interactions stemming from conflict-driven migration and the relocation of IDPs. The former (climate changes) lead to challenging contexts such as drought, while the latter (external migration and IDP resettlement) lead to new social pressures. Given the fluidity and rapidity of changing circumstances in Iraq and Syria, large portions of all these sub-set populations have migrated over the region’s porous boundaries. Neither watershed boundaries nor territorial boundaries are sufficient to form a contained system in defining a fixed complexion of the various socio-economic strata that characterize these states.

Figure 5. Syria and Iraq main ethnic and religious groups



Source: Goldkorn 2015b⁹²

Figure 5 shows the location of the main ethnic and religious groups across Iraq and Syria. From a religious perspective, the main religion in Iraq is Islam; it is followed by about 99 percent of the adult population. Between 60-65 percent of Iraqis are adherents of Shia branch of Islam, while 32-37 percent are adherents of the Sunni branch. In Syria, Muslims make up 87 percent of the country’s population, which includes Sunnis at 74 percent and Alawi, Ismaili, and Shia 13 percent; Christians make up 10 percent; Druze compose 3 percent; and the Jewish populations based largely in Damascus and Aleppo compose less than one percent.⁹³ From an ethnic standpoint, the Arab ethnic majority is spread across central and southern Syria and Iraq, and the Kurdish population makes up the largest ethnic minority spread primarily across northern Iraq and Syria.⁹⁴

In terms of ethnoreligious identity, Kurds are more likely to identify themselves as Sunni Muslims than Shia or other religious affiliation.⁹⁵ Iraq, like neighboring Syria, has a number of smaller ethnic minority groups. These include Yezidis whose religion exhibits both Muslim and Christian aspects and practices, making them particularly vilified by ISIS as both Muslim infidels and non-Muslim nonbelievers.

What needs to be stressed as a primary focus for further examination, in light of ongoing reconstruction in Iraq and future reconstruction in Syria, is the need to provide a spatial depiction of these multiple groups relative to water and energy resources. This report’s findings suggest that

⁹² Giacomo Goldkorn, “Syria and Iraq Main Ethnic and Religious Groups,” *GeopoliticalAtlas.org*, February 22, 2015. Map uses data from www.esoc.princeton.edu and www.icr.ethz.ch/data/other/greg.

⁹³ “Religions,” *CIA World Factbook* (Washington: Central Intelligence Agency (CIA), 2016).

⁹⁴ “Ethnic Groups,” *CIA World Factbook* (Washington: CIA, 2016).

⁹⁵ Besheer Mohamed, “Who are the Iraqi Kurds,” Pew Research Center, August 20, 2014.

significant discriminatory practices exist in how basic services are provided to varied demographic groups in both states. If true, such discrimination could have contributed to the outbreak of significant internal conflicts and fragmentation within these countries. Efforts to explore the relationships between discriminatory practices and instability could be informed by mapping the location of key demographic groups in these countries and the location and provision of basic water and energy resources in these countries.

Section Three. Electricity in Iraq and Syria

Electric power is essential for the cleansing, pumping, and distribution of potable water. Thus where electric power is lacking so too, in many cases, is clean water. The state of the electricity sectors in Iraq and Syria reflect years, if not decades, of conflict, violence, and destructive actions targeting energy infrastructure. Outright civil war in Syria and more recent large-scale factional in-fighting within Iraq have left these industries in varying degrees of disrepair.

Not unlike undertaking a pilot assessment of water infrastructure and networks in Iraq and Syria, ascertaining the current functional state of these countries' ability to deliver electricity services suffers from a huge information gap. The Syrian government has lost control over many areas of the country and is incapable of monitoring or reporting on areas it no longer controls. Humanitarian access to areas is inconsistent at best. Areas undergoing conflict pose physical danger and violence to crews that otherwise would be capable of assessing the state of fixed electricity sector assets and service delivery. Having said this, as water is to human security so is electricity to the functioning of a modern economy capable of sustaining itself.

There is therefore no other option than to attempt, on a pilot scale, to assess the current state of power systems in both countries as a fundamental measure of how much reconstruction or new-build construction will be required for the Iraqi and Syrian economies to recover after this conflict. Given the scale limitations of this pilot study, only a snapshot can be offered here of the electric power sectors in both countries. This study acknowledges that a full-scale assessment of these network systems will be critical to execute in the future.

Syria

Whatever transpires in Syria in the future, it will face of range of inter-related challenges in needing to rebuild its infrastructure; regain economic vibrancy and solvency; rebuild the lives and homes of the Syria diaspora currently spread across Iraq, Lebanon, Jordan, and Turkey; and reintroduce political stability and peace at home. To put reconstruction and recovery into some comparative perspective, according to Gobat and Kostial:

[I]t took Lebanon—which experienced 16 years of conflict—20 years to catch up to the real GDP level it enjoyed before the war, while it took Kuwait—which endured two years of conflict—seven years to regain its pre-war GDP level. Given the unprecedented scale of devastation in Syria, it may be difficult to compare Syria with other post-conflict cases. That said, one estimate asserts that if Syria the post-conflict rebuilding period begins in 2018, and the economy grows at its trend rate

of about 4½ percent, it would take the country about 20 years to reach its pre-war real GDP level.⁹⁶

Central to Syria's full economic recovery is the performance of its electricity sector. The conflict begun in Syria in 2011 is now moving toward its sixth year. According to a World Bank 2009 working paper on the electricity sector in Syria, approximately 99 percent of the pre-war Syrian population served by the ministry responsible for electric power distribution had electricity access in service areas covered.⁹⁷ In contrast, an IMF assessment found that by 2013, at least 30 of Syria's power stations were inactive, and roughly 40 percent percent of the country's high voltage transmission lines had been either debilitated or destroyed.⁹⁸ According to the World Bank, in 2009 Syria had 76 power generation plant stations.⁹⁹ Therefore these 30 inactive stations in 2013 translate to 40 percent of installed generation plants in Syria, and this was *prior* to the 2014 large-scale ISIS assault across much of Syria and Iraq to establish its caliphate. Given time and resource limitations, this pilot study cannot explore the current functional state of Syria's power generation plants. It may be useful for future research, however, to list them here for follow up research purposes (see Figure 6).

Figure 6. Power generation plants in Syria

Plant	Organization	Type	# of Units	Capacity (MW) Unit	Installed Capacity (MW)	Available Capacity (MW) Unit
Baniyas	Public Establishment for Electricity Generation and Transmission (PEEGT)	Gas Turbine	1	30	30	0
		Steam Turbine	4	170	680	340
Mehardeh	PEEGT	Gas Turbine	1	30	30	0
		Steam Turbine	2	165	330	290
		Steam Turbine	2	150	300	240
Tishreen	PEEGT	Gas Turbine	2	112.5	225	200
		Steam Turbine	2	200	400	400
Nassrieh	PEEGT	Gas Turbine	3	112.5	337.5	330

⁹⁶ Gobat and Kostial 2016, 19.

⁹⁷ World Bank, *Syrian Arab Republic Electricity Sector Strategy Note, Report No. 49923-SY* (Washington: World Bank, 2009), 2.

⁹⁸ Gobat and Kostial 2016, 11.

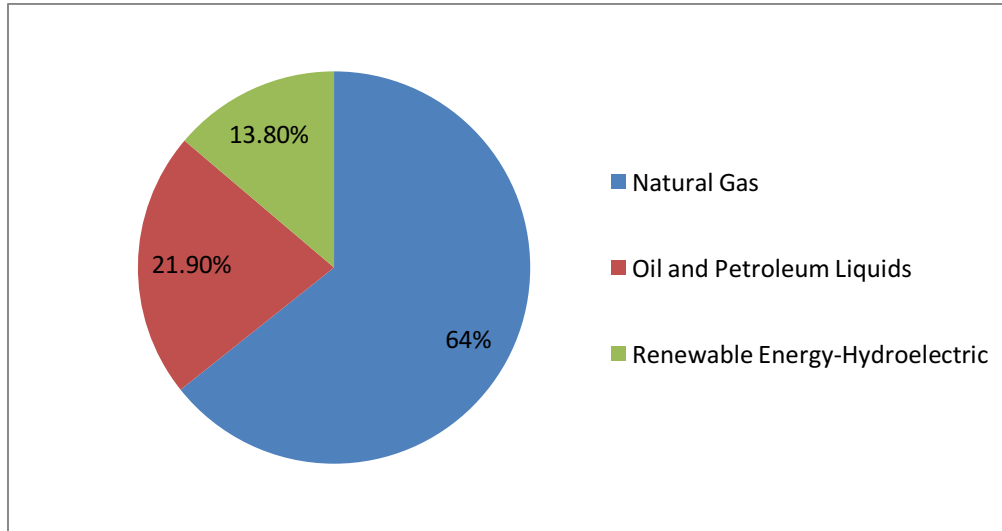
⁹⁹ World Bank 2009, 84.

		Steam Turbine	1	150	150	150
Jandar	PEEGT	Gas Turbine	4	118.5	474	440
		Steam Turbine	2	114	228	200
Zayzoon	PEEGT	Gas Turbine	3	112.5	337.5	330
		Steam Turbine	1	150	150	150
Aleppo (Halab)	PEEGT	Gas Turbine	1	30	30	0
		Steam Turbine	5	213	1065	1065
Tayyemn	PEEGT	Gas Turbine	3	34	102	68
Swedieh	PEEGT	Gas Turbine	5	34	170	136
Alzara	PEEGT	Steam Turbine	3	220	660	660
Syrian Petroleum Company	Other Public Sector (PS)	Gas Turbine	6	20	120	60
Homs Refinery	Other PS	Steam Turbine	2	32	64	40
Banias Refinery	Other PS	Steam Turbine	4	12	48	0
Thawra Refinery	Other PS	Hydro	8	100	800	650
Baath Dam	Other PS	Hydro	3	25	75	51
Tishreen Dam	Other PS	Hydro	6	105	630	450
Public Establishment for Distribution and Exploitation of Electric Energy (PEDEEE)	PEDEEE	Hydro	2	8	16	0
		Hydro	1	7	7	0
System Total			76 Units		7,459	6,250

Source: Author compilation of data in World Bank 2009¹⁰⁰

¹⁰⁰ Ibid.

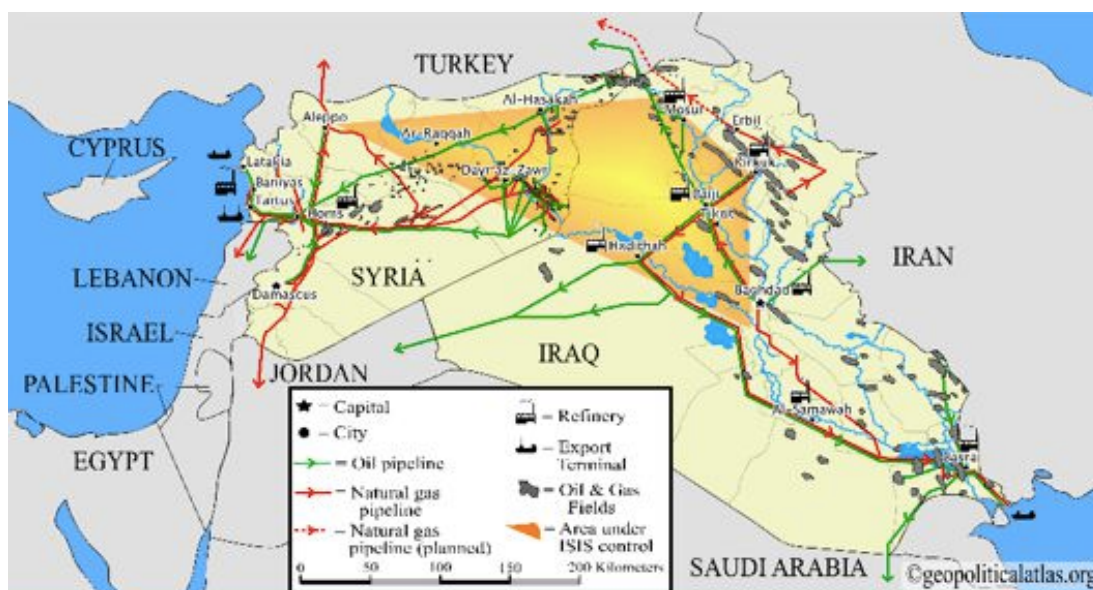
Figure 7. Syrian electricity production by source fuel



Source: Author compilation drawn from IEA 2014 World Energy Statistics

The Syrian fuel mix for electricity generation is shown in Figure 7. As the graph indicates, most of Syria's electricity is based on fossil fuels with the majority coming from natural gas, followed by heavy oil and petroleum liquids. It is an often overlooked point that pre-war Syria was the eastern Mediterranean's largest producer of oil and natural gas, and some of which was diverted to electric power generation. In both the Middle East and elsewhere such as Europe and the United States, very little electric power is typically based on oil or oil products. It is also noted that in the case of ISIS they moved initially and quickly to seize eastern Syrian oil field assets in order to finance their activities. This may have had a secondary impact on the availability of these resources as fuels for power-generation purposes. The debilitation of natural gas pipelines would have the same negative power-sector effect. Figure 8 shows the oil and gas fields in Syria and Iraq controlled by ISIS in 2014.

Figure 8. Oil and gas fields in Syria and Iraq controlled by ISIS



Source: Calzoni 2015¹⁰¹

Early reports from 2014 indicated that power-generation plants fueled by natural gas had been less affected than those fueled by oil or heavy diesel. This analysis reflected on the observation that, at that time, “[a]ccording to government figures, Syria’s natural gas production has declined much less steeply than oil output in the course of the conflict, falling to 5.9 billion cubic meters in 2013 compared to a peak of 8.7 billion cubic meters in 2011. Last year’s production was actually higher than in 2009, thanks to the start-up of two large projects (Hayyan and Ebla) in 2009 and 2010.”¹⁰²

A less pronounced decline in power generated from natural gas could be attributable to the lack of alternative uses for diverted gas and, more interestingly, to the now-accepted theory that ISIS and Syrian government forces worked together to keep the gas flowing and the lights on when it was of advantage to both parties. For example, unconfirmed reports (Orient News an Assad-opposition news outlet) in March 2015 suggested an agreement of understanding had been signed between the Syrian regime and ISIS over the operation of the thermal power plant in Aleppo. This agreement pertains to the division of the electricity supply between the parties, whereby ISIS will receive 60 percent of the quota and the Syrian regime will receive 40 percent.¹⁰³ According to another source, the agreement is designed to solve the power shortage in the Aleppo province.¹⁰⁴

¹⁰¹ Davide Calzoni, “Oil and Gas Fields in Syria and Iraq Controlled by ISIS,” *GeopoliticalAtlas.org*, February 22, 2015. Map uses 2014 data from the U.S. Energy Information Administration (EIA).

¹⁰² David Butter, *Fueling Conflict: Syria’s War for Oil and Gas*, Carnegie Middle East Center, April 2, 2014.

¹⁰³ *Pragmatic Cooperation Between Enemies: The Syrian Regime and ISIS Maintain Tacit Understandings about Operating Oil and Gas Fields and Marketing Their Products* (Ramat Hasharon: The Meir Amit Intelligence and Terrorism Information Center, 2015).

¹⁰⁴ *Ibid.*, 4.

In addition to being difficult to confirm such an allegation generally, it is also difficult to confirm given the complexities in Syria's ongoing multiple conflicts. It is worthwhile to note that eastern Aleppo was home to opposition forces cast largely as Sunni and not as ISIS. As such, the fight for Aleppo has been largely couched in sectarian terms of Shia versus Sunni and not in terms of a showdown between Assad government forces and ISIS.¹⁰⁵

All of this is to say that any assessment of what has happened to Syria's electric power sector must take into account the health of these fuel-network support systems that supply them. Associated infrastructure in both systems, with few exceptions worldwide, are particularly vulnerable to unwelcome intervention by third parties as their respective pipeline networks simply sit on top of the ground unprotected. Further, they often traverse long distances, which make them impossible to protect particularly in distant rural or desert landscapes and conditions. Therefore, electricity continuity and function in Syria is in part a function of the integrity of the generating facilities but also of the fuel-systems on which they depend. Taking this full-system approach into account, it was an incredible miscalculation on the part of the Syrian government not to account for this link and its importance to the integrity the country's power generation.

From a national or regional security perspective, it will be important for military historians and strategists to understand the nature of this strategic failure in dealing in other theaters of cooperation with ISIS-like organizations in the future. For example, according to figures from the U.S. Energy Information Administration (EIA), Syrian oil production went from approximately 500,000 b/d in 2004 to less than 100,000 b/d by mid-2013 and has continued to decline since then with the ISIS insurgency into areas of Syrian crude oil production in eastern Syria.¹⁰⁶ The knock-on effect of these events to the power generation sector is implicit in the downward slide of heavy fuel oil for power generation.

Electricity Supply

In 2010, Syria generated almost 44 billion kilowatt hours of electricity, 94 percent of which came from conventional thermal power plants. According to 2009 World Bank data:

[T]he total installed power generating capacity in Syria was about 7,500 MW in 2007, of which 6,250 MW was actually available; this capacity was inadequate to meet peak demand of 6,566 MW in 2007. No new capacity was added to the system between 2001 and 2006 but, in 2007, 300 MW was added through conversion of an existing plant. Further, a major new 750 MW gas-fired plant was expected to become fully operational during 2009, and expansion of two existing power plants by a total of 750 MW was expected to be completed by the beginning of 2010. Without further capacity additions, however, the demand-

¹⁰⁵ Martin Chulov and Kareem Shaheen, "Sectarian Fighters Mass for Battle to Capture East Aleppo," *The Guardian*, September 29, 2016.

¹⁰⁶ EIA, *Syria* (Washington: EIA, 2015), 4.

supply gap will increase. Base case demand forecast projected a 67% increase in electricity demand during 2009-2020. It was estimated in 2009 that this would require the addition of about 7,000 MW of new generation capacity during the same period.¹⁰⁷

A post-conflict needs assessment in the power sector will thus be expected to highlight the need for an exponential increase in new capacity. This would be needed to fill the gap created by the destruction of hard physical assets and to meet surging demand in a post-conflict Syria focused on the recovery of the Syrian economy and sufficient power for returning Syrian refugees from the near-and-far abroad.

Fuels

As Figure 7 depicts, refined petroleum products and natural gas are the dominant fuels used in Syria's thermal generating facilities. Pre-war Syria had planned to convert all thermal generation facilities to run on natural gas, but this has been postponed until the end of hostilities. This is not surprising, as natural gas as an energy source has been rising since the 1980s, displacing petroleum liquids in the power-generation sector. Since the onset of hostilities in 2011, energy consumption has fallen precipitously. This is also not surprising given the impact of the Syrian conflict on the population's ability to access power, the fall in industrial output, and the inability to generate and transmit power to the combined end-user community through the destabilization and destruction of its high-voltage transmission line network.

Again due to the lack of reliable data, it is difficult to appreciate just how far Syria's electricity output has fallen. Yet if statistics compiled by the International Energy Agency (IEA) are any indicator, in 2012 Syria produced, from all sources, a reported 33,212 GWh of electricity.¹⁰⁸ By 2014, however, production had fallen to 21,726 GWh.¹⁰⁹ This reflects a decrease of approximately 37 percent from 2012 figures, and this does not take into account losses in transmission and distribution that have been exponential given the 40 percent of transmission lines that have been targeted by multiple parties to the conflicts. The more sanguine of analysts, however, present a different picture. Butler, for example, noted in 2014 that:

Data from the Public Establishment for Electricity Generation (PEEG), a Syrian government-owned electricity company, show power output of 38.5 billion kilowatt hours in 2012, compared with a peak of 43.8 billion kilowatt hours in 2011. Active installed capacity was listed as 6,700 megawatts in 2012, down from 8,500 megawatts in 2011. As of February 2014, the PEEG announced peak loads of about

¹⁰⁷ World Bank 2009, 3-4.

¹⁰⁸ "Syrian Arab Republic: Electricity and Heat for 2012," International Energy Agency (IEA), 2016.

¹⁰⁹ "Syrian Arab Republic: Electricity and Heat for 2014," IEA, 2016.

5,800 megawatts, suggesting that Syria's power infrastructure is still relatively robust.¹¹⁰

These dueling statistics demonstrate first of all the problem of getting robust, reliable, and valid data across space, time, and institution. They also highlight the challenge of re-establishing a reliable statistical baseline for Syria's electricity sector based on a common set of accepted data based on agreed methodology.

Overall, the last reliable Syrian energy data was for the period 2009-2010. During this reporting period, the Syrian electricity sector can be summarized as follows. The purpose of raising or highlighting the following points is to be capable of demonstrating comparisons, wherever possible, between the 2009-2010 baseline data in the electricity sector and more current figures presently available. Briefly, the Syrian electricity sector exhibited the following characteristics in 2009-2010:

- A narrowing of the gap between energy supply and demand through the augmentation of generating capacity and, in doing so, a reduction in power outages,
- A remaining unmet demand of approximately 427 GWh in 2007 due to the accelerating increase in demand (from population growth and economic growth) and the lack of available electricity-generating capacity to meet that demand,
- An interest in expanding transboundary energy cooperation both through trade in fuels and in power sharing,
- A 27 percent loss of electricity due to total system losses, and
An electricity outage frequency of 43 days per year in 2007.¹¹¹

Electricity in Syria's Post-Conflict Economy

The organization of post-conflict Syria's electricity sector will be forced to mirror and adapt to any potentially new political configurations there may be in the country. For example, in the event of permanent political fragmentation in the country, management of the electricity sector will potentially require parallel but non-coordinating institutional bodies reflecting those divisions. The post-Iraq war parallel management of domestic water and electricity infrastructure shared between Regional Kurdistan Government and the Iraqi national government in Baghdad may serve as a precedent for future Syrian administrative and institutional power-sector developments. Conversely, if Syria remains a state with a centralized administrative structure, it will be critical to the political stability of that state to reconstruct and rebuild its infrastructure on a non-discriminatory basis. Such a policy would require a herculean effort and be reflected through non-

¹¹⁰ Butter 2014, no pagination.

¹¹¹ World Bank 2009, 1, 2, 29, 31. These observations are summarized here for the convenience of the reader and are available in full in the report.

discriminatory access to electric power and other resources like water if a reconstituted Syrian state would have any chance at all at long-term political stability and economic recovery.

As noted earlier, prior to the outbreak of turmoil, Syria was the eastern Mediterranean's largest producer of crude oil and a marginal producer of natural gas, although output of both was declining. The importance of oil and oil product production to the country's electricity sector was significant for many reasons. These reasons include oil's contribution to Syria's balance of payments, national energy security, and overall economic profile.

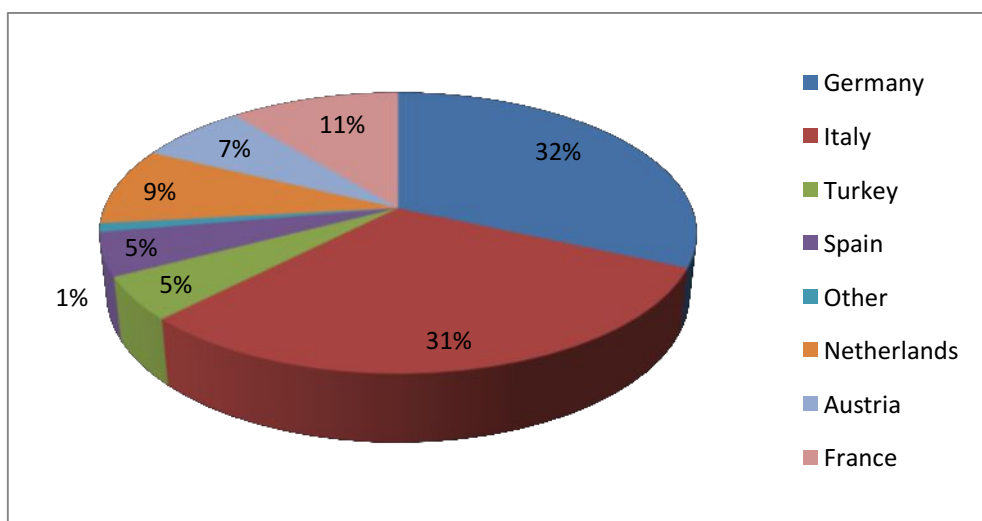
However, as conflict overtook the country, the news media reported in May 2015:

Syria's oil production, once the country's mainstay, has plunged to a record low of 9,500 barrels per day (bpd), strangling an economy battered by more than four years of civil war and sending domestic fuel prices sky high. The oil sector produced 380,000 bpd before the conflict broke out in March 2011. Of that, Syria exported 130,000 bpd, while the remainder was for domestic use. However...output plunged to a paltry 2.5% of pre-war levels, Syrian Oil Minister Suleiman al-Abbas announced at the beginning of May [2015].¹¹²

Oil had always been one of the mainstay's of Syria's exports and of the economy itself for generating hard currency imports. Syria's current poor oil profile has had two impacts. First, without oil income, the government's ability to wage war and even supply its own military with fuel has been severely hampered. The second oil-related impact or by-product of the war is that, in the future, Syrian oil exports can be expected to be redirected to Russia and Iran, which have helped Syria finance the war. Prior to the current turmoil, the vast majority of Syrian oil exports went to Europe, as noted in Figure 9.

¹¹² Antoine Kaser, "Syria's War Sends Oil Output Crashing to Almost Nothing," *The Arab Weekly*, May 15, 2015.

Figure 9. Syrian crude oil exports by destination, 2010



Source: Author compilation from EIA data¹¹³

Russia and Iran have spent billions to bolster the regime of Bashar al-Assad by providing assistance to finance the Syrian government’s war effort.¹¹⁴ Since Syria has little else of value for trade purposes, the destination of oil from post-conflict Syria will likely be sent to one if not both of these countries for repayment purposes. In fact, in 2012, Syria’s Prime Minister Wael al-Halqi had already announced that Syria was going to redirect its exports after European countries announced to boycott Syrian oil.¹¹⁵ In the future, Russian and Iranian market destination for oil exports is assured.

For the post-conflict electricity sector, a recalculation of the potential value of Syrian oil field investment based on anticipated output will be necessary to ascertain the viability of reinvestment in these maturing fields as an option to help pay for reconstruction in Syria’s electricity industry in a post-conflict era. If domestic and/or foreign investment resources are not forthcoming in a post-conflict Syria then, with the exception of the country’s own electricity assets, Syria’s only other option for re-electrifying the country will be to regionally integrate its electricity sector with that of its neighbors. This may require Syria to re-evaluate the ownership structure of its domestic electricity industry, which it had slowly been moving towards privatization in pre-war Syria, but had not made it very far down this path. According to World Bank data, electricity generation, transmission, and distribution were partially unbundled in 2009 while no private investment was allowed in the sector, unlike neighboring Jordan and Egypt.¹¹⁶

¹¹³ EIA 2015.

¹¹⁴ Eli Lake, “Iran Spends Billions to Prop Up Assad,” *Bloomberg*, June 9, 2015.

¹¹⁵ Ziad Haydar, “Syria Turns to Iran for Electricity, Leaves Regional Power Grid,” *Al Monitor*, October 19, 2012.

¹¹⁶ World Bank 2009, 2.

Clearly in order to accelerate post-war investment in the electricity sector the government will have to liberalize public policies, and the electricity sector assets they regulate. Both Jordan and Egypt have done so with varying degrees of success, but the fact remains they have done so and Syria has not. In short, government policy change, adaptation, and economic reform within the context of a new Syrian reality will at least partially determine how quickly and efficiently post-conflict Syrian electricity network supply comes back online.

For the network itself, it will be of particular interest to follow the future of natural gas power generation in the country. It has already been noted that (1) the country was already moving towards greater natural gas consumption in power generation prior to hostilities, and (2) it remained a marginal but declining natural gas producer. In fact, the EIA notes that “in 2008, Syria became a net importer of natural gas.”¹¹⁷ However, increasingly due to sanctions—on Syria and on Iran as a potential natural gas exporter to Syria—its only option was to rely on gas imports through the Arab Gas Pipeline, which has been repeatedly attacked by Bedouin tribesmen in the Egyptian desert after Egypt’s own failed Arab Spring. Therefore, pre-conflict speculation of converting Syria’s thermal electricity generation network away from oil to gas remains elusive. In the future, such a transition shall remain largely a function of potential gas imports in an unstable region.

Regional Electricity Integration

Prior to hostilities, Syria, Jordan, and Egypt were members of an electric interconnection project, which also includes Iraq, Lebanon, Libya, Palestine, and Turkey. Egypt supplied Syria and Lebanon with electricity over the Jordanian network. In 2012, news media reported that “Iran had begun to compensate for the shortage of electricity in Syria, which had suffered from significant losses in electric power” through an agreement to export 250 MW of power to Syria.¹¹⁸ Prior to this, a memorandum of understanding (MOU) had been signed between Syria and Turkey that addressed how the two countries could cooperate in the fields of electrical power, renewable-energy generation, and distribution to enhance the efficiency of the electrical grid. As media reported, “[u]nder the MOU, Turkey supplied Syria with quantities of electricity that did not exceed 3% of Turkey’s total production. The deal was valued at \$100 million between 2007 and 2008, according to official sources.”¹¹⁹ This agreement, like other electricity import trade agreements, was nullified after the intensification of hostilities in Syria. However, the precedence of regional electricity integration remains in place. It is an interesting aside that under UN sanctions, electricity imports from Iran were allowed to continue while the better-known sanctions on Iranian oil and gas exports remained in place. Now that Iranian sanctions have been lifted, if hostilities in both Iraq and Syria can be shut down, integrated electricity networks may be in the

¹¹⁷ EIA 2015, 5.

¹¹⁸ Haydar 2012.

¹¹⁹ Ibid.

region's future, with its hub in Iran and with strong downstream markets in both Iraq and Syria. Such calculations have largely not been publicly discussed in Western analytical circles.

In 2009, the World Bank had already speculated on the link between Syria and regional integration when it wrote that:

To enhance integration of Syria within the Mashreq region and eventually with the EU market the following regional projects could be considered:

Electric Power: (i) construction of a 400 kV interconnection with Iraq and a gas-fired generation plant supplied by gas from the Iraq's Akass field, which is close to the border with Syria. This plant could supply electricity to Syria and Iraq and possibly to Jordan; and (ii) rehabilitation and reinforcement of the existing 400 kV interconnection between Syria and Turkey.

Natural Gas: (i) complete the final two stages of the AGP within Syria (Aleppo-Kilis and Aleppo-Furglus); (ii) complete the AGP link to the Turkish gas network; and (iii) build a gas pipeline from central Iraq through Syria to the AGP, for domestic consumption and export, the latter either via an LNG terminal or via the Turkish transmission system to Europe.¹²⁰

In a post-conflict Syria, it is presently unknown if there will be any appetite for transboundary cooperation where both electric power and water are concerned. The one thing that is exceedingly clear however is that, given the amount of devastation in Syria and other commodity challenges, regional cooperation and integration could be a viable way forward, but it is one that will be decided not only by regional players but influenced by members of the international community as well.

Devastation

According to the IMF, with the exception of the housing sector, Syria's energy sector has suffered more damage to its infrastructure than other sectors in Syria, with a low estimate of \$648 million and a high estimate of \$719 million.¹²¹ This assessment was conducted only for Syria's six largest cities and compared baseline data from 2011 with a damage assessment made for these cities in 2014. The size and value of current estimates for 2016—a full two years after this assessment was carried out—may thus be much higher.

On March 3, 2016, news media reported that:

Syria's electricity minister Imad Khamis [had been]...called into parliament for a special hearing on the power sector.... He told the country's lawmakers that the

¹²⁰ World Bank 2009, 5.

¹²¹ World Bank, Courage Services, 2014, cited in Gobat and Kostial 2016, 21.

cost of ‘direct damage’ to the country’s power stations and the electricity network from 2011 to the end of 2015 was around £2.6billion. Khamis said five of Syria’s 13 main power stations had been ‘directly damaged’ in the conflict.¹²²

Even this large figure appears to vastly underestimate the cost of bringing the country’s electricity system back online. For example, in April 2016, news media reported that:

The United Nations estimates that 158 billion euros must be invested to bring back the gross domestic product (GDP) to its level prior to the conflict, while the Syrian Center for Policy Research, estimated the cost of the destruction in infrastructure to be about 75 billion dollars (66 billion euros), and that it’s expected that the cash reserve in Syria has dropped to two billion dollars just in 2013.¹²³

What is clearly required, and without it an imminent barrier remains particularly for development professionals, is a comprehensive assessment of Syria’s electric power industry on a plant-by-plant basis to assess what requires repair or re-build and where. It’s critical that this analysis include an assessment of the consequences of this devastation on the human health of affected populations in order to devise a triage approach towards refurbishment and reconstruction of electric power on a priority basis.

In summary, the exact state of debilitation in Syria’s electric power sector, exemplified here by the country’s fleet of power generation plants, is unknown. At a minimum, however, the cost of reconstruction in the infrastructure sector was estimated at \$4 billion already in 2014,¹²⁴ and it is probably much higher.¹²⁵

In summary, several key points are:

- The Syrian government’s loss of control over some areas’ power plants, ISIS control over some areas’ power plants, and Syrian opposition control over other areas’ power plants all hinder access to and accurate reporting on the country’s power sector.
- Physical debilitation and/or destruction of fixed assets is only one cause in the fall of power output as fuel shortages. Pilfering and illegal bunkering of heavy oil and diesel also contribute to the decline in power production.
- As early as 2012, the Syrian oil minister indicated that Syria would export available oil to Russia to pay for their assistance to the Assad regime. It is expected in the future that Iran will also be a recipient of Syrian oil exports provided they come back online.

¹²² Jay Akbar, “Syria Hit by Nationwide Power Cut and Internet Blackouts Three Days After Its Government Was Warned of Huge Damage to Power Station,” *Daily Mail*, March 3, 2016.

¹²³ Enab Baladi – Economy, “The Hard Currency Reserve in the Central Bank of Syria ‘Dries Out,’” *Enab Baladi English*, April 24, 2016.

¹²⁴ Syrian Economic Forum, *60 Thousand Disabled Industrial Facilities in Syria....And the Cost of Reconstruction is 21 Billion Dollars*, May 2, 2014.

¹²⁵ Gobat and Kostial 2016.

- Reports indicate that natural gas delivery to power stations has been less affected than conventional thermal power plant electricity production from oil and oil products. There are a variety of explanations for this, including collusion between the Syrian government and opposition forces and between the Syrian government and ISIS and the fact that unlike oil, which is easily portable, natural gas is hard to divert and has little or no secondary market.
- Many of the country's transmission lines have been impacted by violence and (presumably) theft. This further contributes to the poor transmission of electricity, particularly in areas beyond the control of the central government.
- While there has been a recognition of the relationship between electric power, water availability, and the quality the human health, aspects of this relationship in Syria have yet to be explored—much less confronted.

Iraq

Similar to its neighbors such as Syria, Turkey, and Iran, Iraq has electricity demand that outstrips supply, partially as a result of the demands of a growing population and partially as a result of economic growth. However, even more than neighboring Syria, Iraq has suffered from decades of destruction as the result of numerous wars, internal conflicts, and—now like Syria—an insurgency from ISIS. All of this has taken a physical toll on its electricity network.

Electricity production in Iraq has had difficulty in keeping pace with demand since 2002. In 2011, Iraq produced approximately 54.24 GWh of electricity, according to World Bank statistics.¹²⁶ Using the same dataset, the World Bank estimated that Iraq power demand over the same period was approximately 42.245 GWh.¹²⁷ However in 2012, the IEA estimated that the net capacity available at peak levels in 2011 was around 9 GWh, while the estimated net capacity required to meet peak demand was 15 GWh, resulting in a need for around 6 GWh more available capacity—an increase of around 70 percent.¹²⁸

Despite significant progress made in increasing electric power production in Iraq since 2010, the country remains plagued by rolling electricity blackouts, particularly outside the capitol of Bagdad. Iraqis augment the difference between available grid-based power with diesel-generated power, which is both extremely dirty and costly. Most households have access to electrical grids, yet stability and supply are the real challenges—more so than connection to the network. There is access to secondary sources of electricity. Most people share generators. Shared generators are most common in the central and southern parts of Iraq, whereas private generators are most

¹²⁶ World Bank, “Electricity Production (KWh) in Iraq,” *Trading Economics*, 2011.

¹²⁷ Ibid.

¹²⁸ Estimates taken from data presented in IEA, *Iraq Energy Outlook* (Paris: IEA, 2012), 30.

common in Baghdad and northern regions. In southern Iraq, especially Basra Governorate, power supply lasts only six hours per day.¹²⁹

According to another source, daily power outages of up to 16 hours a day have not been uncommon over the 2003-2012 period.¹³⁰ As a result, Iraq has had to import electricity from Iran and from Turkish electricity barges (floating power plants) in the Persian Gulf.¹³¹ Further it is estimated that the total cost to the Iraqi economy attributable to power shortages exceeds \$40 billion annually.¹³²

Iraq's primary energy use and its fuel profile in the electricity sector are similar to other countries in the Middle East. As is presently the case in other Middle Eastern countries, Iraq is fuel switching away from oil and oil liquids to gas for power production. While Iraq is known as an oil giant, based on its two supergiant fields and other significant finds, most of its gas comes from associated gas or gas trapped above its oil deposits as opposed to a gas field that is generally deeper underground and that is defined as containing more gas than oil. Associated gas can be used for re-injection to increase pressure in oil wells to boost output. It can also be burned off or 'flared' to dissipate it in the atmosphere. It can also be captured through the introduction of technology and be put to other uses such as generating power in a gas-fired power plant. Requisite technology and infrastructure needs to be put in place for this latter operation. According to the EIA, "three-quarters of Iraq's natural gas resources are associated with oil."¹³³ The majority of non-associated reserves are concentrated in several fields in the northern part of Iraq, including Ajil, Bai Hassan, Jambur, Chemchemal, Kor Mor, Khashem al-Ahmar, and al-Mansuriyah.¹³⁴

Unfortunately, Iraq has continually delayed implementation of a 2005 Gas Master Plan that would trap associated gas sufficient enough to supply several million homes in Iraq with gas for electricity. Because of this failure in domestic policy implementation, in August 2016 Iraq began importing gas from its now sanctions-free neighbor Iran. At the time it was reported that, "[t]he imports were to begin at 7 million cubic meters a day for power generation in Baghdad. Another export route is planned for 2017, which will serve Basra, totaling 70 million cubic meters a day in exports."¹³⁵

In 2003, oil in the form of petroleum liquids—i.e. heavy diesel, fuel oil, and oil-fuels—accounted for approximately 98.5 percent of electricity generation by fuel in Iraq. By 2010, oil's percentage

¹²⁹ See for example "Iraq Speaks: Citizen Reports," *Al Jazeera*, no date. Available at <http://webapps.aljazeera.net/aje/custom/electricityiraq/index.html>.

¹³⁰ "Electricity," *GlobalSecurity.org*, no date.

¹³¹ Eye Media Company, "Two Turkish Ships to Supply Basra with 250 Megawatts of Electricity," *Iraq Business News*, March 16, 2010.

¹³² World Bank, *Iraq - Integrated National Energy Strategy Technical Assistance Project* (Washington: World Bank, 2013), 12.

¹³³ EIA, *Country Analysis Brief: Iraq* (Washington, EIA, 2016), 12.

¹³⁴ *Ibid.*

¹³⁵ Simon Kent, "Iranian Gas Imports for Iraq in September," *Iraq Business News*, August 16, 2016.

of fuel in power generation had been significantly reduced to 34.3 percent due largely to Iraq fuel switching to natural gas for power generation as the BBC reported about Iraq in 2013:

There has already been a significant switch towards gas in electricity production, but more investment is needed to make the most of the natural gas and gas associated with oil production. The IEA estimates that more than half of the gas produced in 2012 was “flared” or burned off, which it describes as “hugely wasteful given the continuing shortfall in electricity supply in Iraq.”¹³⁶

The United States and Iraq have spent an estimated \$213 billion in post-war reconstruction, but the IEA suggests developing “gas gathering and processing facilities...and bringing online new gas-fired power plants” should be “urgent priorities” for the Iraqi authorities.¹³⁷

The difference in what Iraq produces in crude oil and what it consumes domestically for both electricity generation and for other purposes is ultimately what it has available to export. Oil exports fuel Iraq’s economic activity disproportionately. It remains a fundamental input fuel for power production. This dual role gives oil its weighty importance within an Iraqi context. For example, Iraq’s crude oil production averaged nearly 4.1 million b/d in 2015—700,000 b/d more than the production level in 2014 but production was expected to slow somewhat in 2016. In spite of this, Iraq remains OPEC’s second largest producer of crude oil.¹³⁸

In a shift away from oil to other fuels in the power generation sector in Iraq, it is notable to see the increased percentage in overall power produced from hydroelectric. This rose from a low of 1.5 percent in 2003 to an estimated 9.5 percent in 2010. Iraq’s hydropower sector has a gross installed capacity of 2.3 gigawatts (GW), but operating capacity is estimated at less than 1.5 GW, due to a combination of low water levels in reservoirs upstream and constraints imposed by the need to match irrigation flows and safety concerns, as in the case of Iraq’s largest facility at Mosul. For example, in 2011 it was reported that there was no hydroelectric power being produced in Mosul due to the low level of water availability.¹³⁹

Natural Gas Production and Consumption Challenges

As noted, natural gas is playing an increasingly important role in Iraqi electricity production. Most gas produced in Iraq is associated gas located in the south of Iraq, which based on this single variable would point to where most of Iraq’s future gas-powered electricity generating facilities should be positioned. Regardless of where the gas is, however, using this gas requires the needed supply chain to fuel and maintain gas-turbine technology once it is built. In 2011, the lack of this supply chain development—such as fuel handling sub-stations and auxiliary equipment—slowed

¹³⁶ “Iraq 10 Years On: In Numbers,” *BBC News*, March 20, 2013.

¹³⁷ IEA 2012, 24.

¹³⁸ EIA 2016.

¹³⁹ “No Hydropower from Iraq’s Mosul Dam: Official,” *Terra Daily*, January 27, 2011.

the introduction of a large number of new turbines Iraq had purchased as far back as 2008 to add to new electricity generating capacity.¹⁴⁰

In order to boost natural gas field development, the EIA reports that “Iraq held its third bidding round in late 2010 for three non-associated natural gas fields (Akkas, al-Mansuriyah, and Siba) with combined reserves of more than 11 Tcf.”¹⁴¹ Iraq has committed to purchase 100 percent of the gas. A fourth bidding round in May 2012 attracted one bid for a gas-prone area. Iraq natural gas production is per se not controversial, but its export is a factor impacting further developing the Iraqi natural gas sector. However, the big picture in Iraq natural gas development is that Iraqi gross natural gas production has been increasingly consistently over the past decade.

As noted, natural gas is increasingly used as fuel for power generation, while a portion of it is re-injected to enhance oil recovery. Further noted, however, was that the flaring of Iraqi natural gas has been a major issue for Iraq’s power sector. According to the EIA:

To reduce flaring, Iraq signed an agreement with Royal Dutch Shell to create a new joint venture, Basrah Gas Company, to capture flared gas in Basrah Province. The 25-year project costing \$17 billion has a planned production capacity of up to 2 Bcf per day. Under the agreement, processed gas would go to the state-owned South Gas company for domestic use. Any gas not bought for use by Iraqi power plants could be exported as LNG. The agreement, which originally was to cover all of Basrah province, has been modified to include only the associated gas from the Rumaila, Zubair, and West Qurna Phase I projects. Implementation of this agreement is necessary for the new oil development projects (which would use the natural gas for re-injection) to go forward.¹⁴²

In conclusion, there is no easy trade off for using Iraq’s natural gas either in power production, in flaring where some progress is being made for recapturing associated gas, or in using associated gas for re-injection into oil fields to increase production. On the one hand, gas flaring may be cheap, but it leads to a loss of non-sustainable gas resources for productive uses elsewhere. Iraqi re-injection of natural gas to increase oil flow and yield is also a loss for natural gas-fired power generation on which most of the country’s new power generation is based. But displacing gas re-injection with water injection, the only other standard alternative, taxes Iraq’s water availability, which is already under considerable stress.

¹⁴⁰ For an example of slowed development that is now underway, see “GE Signs Agreement with Iraqi Ministry of Electricity; GE Power Up Plan to Sustain and Increase Iraq’s Power Generation for the Peak Summer Period,” *GE Newsroom*, January 28, 2016.

¹⁴¹ EIA 2016, 12.

¹⁴² Ibid.

ISIS and Electricity in Iraq

“By May of 2014, the government was confident that Iraqis would finally benefit from 24 hours of electricity supply based on its plan to add 8,000 megawatts (MW) of generation capacity to reach 20,000 MW by the end of 2015. In the wake of IS’s advance, however, the Ministry of Electricity instead announced grid losses of more than 8,000 MW.”

- Luay Al-Khatteeb and Harry Istepanian, 2015¹⁴³

“Before the 2003 invasion of Iraq, the country’s national grid supplied the capital, Baghdad, with between 16 and 20 hours of electricity each day. But more than a decade after the fall of Saddam Hussein, electricity supplies have dropped to an average of only one hour of power for every four hours of the day - that’s six hours over a 24-hour period.”

- Rashed Radwan, 2016¹⁴⁴

The current state of the electricity sector in Iraq, and the subsystems that provide it fuel, remain primarily a function of location, conflict intensity, and the duration of instabilities on a localized basis. As in Syria, in Iraq continuation and management of these network systems remains a function of the political and institutional configuration of the country. The forced insertion and imposition of ISIS into the civic, cultural, economic, and political life of Iraq—in areas that it has controlled or continues to control—has undoubtedly impacted directly on the delivery of electrical power and water services. As stated below, this has put severe strains on the affected populations and network systems on which they depend.

By May 2016, media reported that the Islamic State had, “lost 45% of the territory it once held in Iraq and 20% of areas it controlled in Syria, according to estimates by a U.S.-led coalition combating the extremist group.”¹⁴⁵ However, “by mid-2016, 3.4 millions Iraqis—almost 10% of the population—were displaced, and millions more were in need of urgent humanitarian assistance” due to a combination of Iraqi internal in-fighting and the ISIS insurgency. Reports noted that “[t]his massive internal displacement, as well as conflict-related economic decline, have put enormous strain on the host communities and strained social systems.”¹⁴⁶

It is important to consider the state of these electricity systems that IDPs and refugees will return to. However, if past experience in the water sector is indicative of ISIS’ slash-and-burn tactics during retreat, then the prognosis for recovered electricity assets formerly under ISIS control is not a positive one. For example, the Balad district that contains a northern Iraqi oil field was overtaken early on by ISIS. Part of this region was liberated after allied bombing in August 2014, but as ISIS forces retreated, they poisoned the water supply with crude oil, making it undrinkable and toxic to

¹⁴³ Luay Al-Khatteeb and Harry Istepanian, *Turn a Light On: Electricity Sector Reform in Iraq* (Doha: Brookings Doha Center, 2015), 1.

¹⁴⁴ Rashed Radwan, “The Man Bringing Electricity to Iraq,” *Al Jazeera*, June 26, 2016.

¹⁴⁵ Jim Michaels, “ISIL loses 45% of Territory in Iraq, 20% in Syria,” *USA Today*, May 17, 2016.

¹⁴⁶ “The Situation of Children in Iraq,” UNICEF, 2016.

those who did.¹⁴⁷ More recently in August 2016, in the same Balad district, as ISIS has continued to lose ground, they have employed the same slash-and-burn tactics as Iraqi troops did themselves in Kuwait as they retreated during the first Gulf War. One report quoted an Iraqi resident of the region saying, “They are suffocating us. The birds, the animals are black, the people are black. Gas rains down on us at night. Now the gas has reached the residential areas.”¹⁴⁸ Another resident similarly noted, “Water is restored, but still no electricity and the issue of the burning oil. They have to put out because the smoke hurts us very much. Gas rains down on houses.”¹⁴⁹

In October 2015, *Foreign Affairs* published an instructive article that addressed the electricity sector in ISIS-controlled territories of Iraq and Syria. While the focus of authors Andrew Shaver and David Engin was to ascertain whether ISIS could actually govern the territories it conquered, the metric they used to determine this was through the electricity sector. As they argue:

There is, however, one way of directly measuring ISIS’ governing performance: through electricity supply, a basic good required to keep house and street lights on; refrigerators, televisions, radios, and other basic appliances running; keeping life support at hospitals operational; and water treatment and processing plants going, to name just a few essential functions. Without electricity, businesses shutter, economic activity grinds to a halt, and millions of workers are displaced.¹⁵⁰

If the author’s findings are correct, then electricity production, transmission, and distribution in ISIS-controlled territories at least initially was dismal. They find that:

- “Electricity production in ISIS-held regions of Iraq fell precipitously following the organization’s spread into the country last year [2014] and, until March [2015], remained abysmally low. (After March, the stream of data goes cold, so this may represent .. [the] best and most updated status of ISIS’ general governing efforts.) Conditions in Nineveh and Anbar provinces are [were] particularly poor. There, electricity levels fell to zero during the last few months of data coverage.”¹⁵¹
- “The biggest contributing factor to ISIS’ inability to generate electricity is the lack of fuel,”¹⁵² as noted earlier in this study. By fuel, Shaver and Engin make particular reference to oil products such as fuel oil and heavy diesel. They correctly point out that seized oil assets may have been diverted away from power plants in order to obtain hard currency for funding their war effort. A second potential reason for power sector failure may have been

¹⁴⁷ Abdelhak Mamoun, “ISIS Poisons Drinking Water with Crude Oil in Balad District,” *Iraqi News*, December 3, 2014.

¹⁴⁸ Tyler Durden, “‘Apocalyptic Scenes’ as Fleeing ISIS Fighters Set Iraqi Town’s Oil Wells on Fire,” *ZeroHedge*, September 2, 2016.

¹⁴⁹ “Video: ISIS Terrorists Fire Oil Wells as They Withdraw in Iraq, People Suffering,” *Alalam*, August 30, 2016.

¹⁵⁰ Andrew Shaver and David Ensign, “Lights Off in the Islamic State: What Electricity Tells Us About ISIS’ Rule,” *Foreign Affairs*, October 23, 2015, no pagination.

¹⁵¹ *Ibid.*, no pagination.

¹⁵² *Ibid.*, no pagination.

that at least early on ISIS did not ‘retain’ non-ISIS personnel key to operating power plants, which in turn led to their willingness to deal with adversarial authorities such as the Iraqi and Syrian governments who had an interest in keeping the lights on and therefore also an interest in compromising with their adversaries. A third reason is that, in general, there is a lack of diesel on which private generators can run and, if they do run, they cannot be accounted for as they are independently operated off-grid.

The restoration of electricity services overall in Iraq, and most dramatically in areas previously controlled by ISIS, is a clear-cut example of steps the Iraqi government can take to win the ‘hearts and minds’ of many sectors of the Iraqi population previously disaffected from the government. An absolutely essential step towards re-establishing local and incrementally broader economic recovery for the country and its people. Here there is a fine balance that the government must strike between realizing national objectives, particularly in the oil sector, and immediate short-to-medium term humanitarian assistance to the Iraqi people where electricity is concerned. As the EIA notes in its most recent Iraq country survey:

Iraq’s oil and gas industry is the largest industrial customer of electricity in Iraq. Large-scale increases in oil production would also require large increases in electric power generation. However, Iraq has struggled to keep up with the demand for electricity, with shortages common across the country. Significant upgrades to the electricity sector would be needed to supply additional power. Delays in meeting projected targets may mean insufficient power supply to meet the projected demands of the oil sector.¹⁵³

The significant point is that the government of Iraq recognizes that it cannot restore electricity supply to the oil sector, regardless of its dominant role in the Iraqi economy, while appearing to ignore the plight of the population. Doing so would be political suicide for the government and would provide fodder for propelling the country backwards.

The EIA analysis previously referenced finds that the current Iraqi electricity sector exhibits the following characteristics:

- “Iraq’s electricity supply totaled almost 79 billion kilowatt hours (KWh) in 2013, of which more than 69 billion KWh was generated from domestic power plants and more than 9 billion KWh was imported from Iran and Turkey.”¹⁵⁴ It should be noted that imports particularly from Iran are politically sensitive, as some see Iran’s involvement in Iraq’s electricity sector—and even more so in the natural gas sector—as a political tactic for maintaining influence over the government in Baghdad.¹⁵⁵

¹⁵³ EIA 2016, 6.

¹⁵⁴ Ibid., 13.

¹⁵⁵ For elaboration on how Iraqi resistance to Iranian natural gas exports to Iraq have held up passage of Iraqi power sector legislation, see Khatteeb and Istepanian 2016.

- “From 2005 to 2013, distribution losses averaged 38 percent of total electricity supply. Iraq’s distribution system, outside the Iraqi Kurdistan Region, has deteriorated because of poor design, lack of maintenance, and electricity theft, resulting in large distribution losses, low voltage levels, and frequent disconnections.”¹⁵⁶ It should be noted that one can add to this significant distribution losses from 2014 on due to action directly attributable to the violence carried out against this sector by ISIS forces.
- “Peak summer demand has typically exceeded actual generation by almost 50 percent, causing power shortages that have sparked protests, particularly in southern Iraq.”¹⁵⁷ It should be noted that protests and problems associated with power supply are exemplified in the southern port city of Basra where Turkish floating electricity barges temporarily cut off power to the city for the reason of non-payment. After the Iraqi government promised payment of some \$85 million in unpaid debts, power was restored.¹⁵⁸
- “Electricity generation in the Iraqi Kurdistan Region had typically been much more reliable than other parts of Iraq. However, the economic crisis in Iraq, caused by the ISIL war and low oil prices, has affected power supply, and because of insufficient natural gas feedstock, the KRG is delivering only 8 to 10 hours of electricity per day. The situation was recently exacerbated as disruptions to pipeline flows transporting natural gas from the Khor Mor field to two power plants in Erbil and Chemchamal caused long power outages.”¹⁵⁹ Iraqi Kurdistan is also home to Iraq’s largest hydroelectric dam, the Mosul Dam, and a number of other hydroelectric facilities. As noted in the previous water section of this study, these facilities may be in the future brought into peril through climate variability and climate events leading to the drying up of the portion of the Fertile Crescent in Iraq.
- “In January 2016, the newly refurbished Najibiya plant came online in Basra, with its capacity upgraded from 90 to 500 megawatts. However, problems at the Najibiya plant occurred shortly after its commencement as the shortage of natural gas supply led the plant’s operator to use crude oil instead. Less than a month later, one of the plant’s storage tanks leaked fuel oil, leading to an oil spill in a nearby river.”¹⁶⁰ The future of Iraq’s electricity industry is tied to Iraq’s ability to recapture presently ‘flared gas’ from the country’s associated gas fields. Secondly, absolutely requisite improvements in lessening Iraqi distribution losses could more than compensate for current electricity imports, but it remains unclear to what extent improvements in curtailing these losses can help meet future Iraqi electricity demand projections. The only other option for large-scale baseload power generation may in fact be a function of regional energy system integration with neighboring

¹⁵⁶ IEA 2012, 92; cited in EIA 2016, 13.

¹⁵⁷ “Heading Off Summer Power Protests,” *Iraq Oil Report*, May 27, 2011; and “Iraq Faces Summer Power Crunch Despite Progress on \$75Bn Mega-Plan,” *Middle East Economic Survey* 56, 26 (2013); cited in EIA 2016, 13.

¹⁵⁸ Ali Al-Aqily, Ben Van Heuvelen, and staff, “Update: Power Cuts in Basra Over Unpaid Bills,” *Iraqi Oil Report*, August 9, 2016.

¹⁵⁹ Mohammed Hussein, Patrick Osgood, Rawaz Tahir, and Kamaran Al-Najar, “Update: Explosion Shuts Down Critical Kurdistan Gas Pipeline,” *Iraq Oil Report*, January 29, 2016; cited in EIA 2016, 14-15.

¹⁶⁰ Ali Abu Iraq, Ali Ugaili, Chloe Cornish, and staff, “Oil Spill Mars Basra Power Plant Expansion,” *Iraq Oil Report*, February 4, 2016; cited in EIA 2016, 15.

Turkey and to a greater extent Iran. This in turn will be a function of bilateral relations between these two countries and of Iraqi internal political stability where Shia-Sunni relations are concerned.

Below are key summary points related to the electricity sector in Iraq:

- It is known that the electricity sector in Iraq suffers from years of conflict-induced damage or destruction, however further study is required to detail the asset type, location, degree of damage, recovery or repair cost, and downstream value to the affected population. The final point in this list is key to understanding the social dimension of energy, including the impact of debilitated energy infrastructure on water quality, water availability, and overall human health impact.
- As in Syria, there is a connection between the lack of available fuel and sufficient amounts of electricity. Due to the destruction of refineries in Iraq, diesel for generators and heavy fuel for conventional thermal electricity production is limited. This has impacted the ability of both the Iraqi government and ISIS to provide electricity in the regions they control.
- It appears that the country would benefit from a more integrated transboundary electricity system given that domestic demand, particularly during peak periods, cannot be met from domestic power generation. There are economic and political costs and benefits to a regional power-sharing approach, based on which the Iraqis must determine if it is a feasible and politically palatable set of relationships to forge.

Section Four. Back to the Future: Energy, Water, and Human Security in Iraq and Syria

In Iraq and Syria, the precarious state of water and energy networks, against the background of unending conflict, is deepening the insecurities of the region's already beleaguered people. There are several keys to unlocking improved policy responses in these sectors to seek to improve the plight of the Iraqi and Syrian people. First, the reconstruction experience in the wake of the Iraq war is decidedly instructive in reflecting what the cadre of past U.S. professionals confronted in attempting to bring back online basic water and energy services in Iraq. Secondly, the lessons from this experience, it is argued here, are transferable to Syria and to present-day Iraq in terms of what type of information is needed at what scale for effective disaster recovery and longer-term reconstruction efforts. Different datasets are required for different levels of analysis to identify the potential range of activities that may proceed from them. Finally, the scale of data and how it is obtained is equally important to the substance of the data itself—and in fact scale informs the substance.

Lessons from Iraq Reconstruction

Assessments conducted by the U.S. Special Inspector General for Iraq Reconstruction (SIGIR) provide valuable insights into all aspects of Iraq reconstruction processes and outcomes. This section identifies several of those lessons with direct applicability to the water and electricity infrastructure topics addressed in this paper relative to events unfolding in present-day Iraq and Syria. The text is remarkable for its blunt honesty and forthright intention to generate increased efficiencies, make important observations on the costs and dangers of conducting reconstruction efforts in an environment of ongoing conflict, and examine how to improve on these practices in potential future theatres of operation. Some of the most salient points drawn from this report that will impact water and energy reconstruction are summarized below.

1. Information: The SIGIR report notes: "The lack of information about Iraq's infrastructure and government institutions made it difficult to determine what was necessary to restore essential services. 'We never had anything more than a PowerPoint briefing,' a Defense official later commented."¹⁶¹

A thorough political-economic analysis of the institutions, policies, decision-making processes, and policy-implementation processes in these sectors is critical during both the pre-conflict and post-conflict phases. The existence of a pre-conflict baseline assessment of network systems and infrastructure has direct impact on the efficiency and pace of post-conflict recovery and humanitarian relief. These assessments should include access to human resources that have broad

¹⁶¹ SIGIR 2009, 11.

knowledge and contextual information regarding the physical configuration of network systems, their critical nodes, and the neighborhoods, communities, or even regions they serve.

*2. Operating Environment: The SIGIR report notes: “Missing from the intelligence, according to USAID’s Wherry, were assessments of the economy, governance, agriculture, and other “soft” aspects of Iraq’s condition. ‘If it couldn’t be got by a satellite, we just didn’t have it,’ he said.”*¹⁶²

Reconstruction must have an understanding of an ally’s or adversary’s economy and the conditions under which it operates, including the interaction of basic industries that support human security such as health, water, and power. This highlights the value and importance of having grassroots intelligence with focused on drawing local impact assessments. This is a sound example of intelligence gathering at its most fundamental and how on-the-ground information gathering can ultimately provide context for information gleaned from imagery obtained from satellite-based GIS monitoring. Also the interaction between critical network systems—such as water and agriculture, electric power and water quality, water quality and human health—are difficult to ascertain in stand-alone assessments of single networks, but these network interdependencies should be examined in detail in the larger human security-infrastructure context. The U.S. Army Corps of Engineers is well-placed to carry out integrated analyses of this nature.

*3. Information 2.0: The SIGIR report notes: “[U.S.] Treasury Under Secretary John Taylor.... established the Treasury’s Task Force on Iraq Financial Reconstruction.... Taylor and his team found that reliable information about Iraq’s economy was almost nonexistent. The International Monetary Fund had not done a technical analysis of Iraq’s economy for twenty years, and Iraqi data-collection entities had atrophied under Saddam [Hussein].”*¹⁶³

Again planning requires complete, current, and reliable information on a country’s economy and other ‘soft aspects’ of the environment within which reconstruction is to take place.

*4. Role of Doctrine and Structure: The SIGIR report notes: “Of the many lessons to be drawn from Iraq reconstruction, the most compelling speak to the need to develop an agreed-upon doctrine and structure for contingency relief and reconstruction operations to guide the use of military and economic power.”*¹⁶⁴

Development of such doctrine is key to ensuring international actors are ready when they next must—as inevitably will occur—engage in an unstable state or in the aftermath of an armed conflict between states. The development of doctrine and structure for reconstruction activities—while requisite, and some would argue pre-requisite, to post-conflict intervention—should remain flexible enough to adapt to and address the local, evolving operating environment. This pilot study provides an example in highlighting the ongoing challenges for Iraq to produce sufficient electricity supply for its oil industry and its population that continues to be deprived of sufficient

¹⁶² Ibid., 22.

¹⁶³ Ibid., 30.

¹⁶⁴ Ibid., 331.

and uninterrupted power. Doctrine that drives forward sustainable political stability, in this case, may require an infrastructure recovery or reconstruction approach that promotes concurrent recovery of electricity supply to both the population and the country's key industrial/economic sectors. Such a doctrine emphasizes the value of humanitarian relief and its contribution to political stability on a footing equal to the provision of power to commercial entities for economic purposes.

*5. The Conflict Burden: The SIGIR report notes: "Iraq's reconstruction environment has never been truly 'post-conflict.'"*¹⁶⁵

One of the most challenging aspects of improving the water and energy sectors in Iraq and Syria is that these ongoing efforts are carrying out repair and reconstruction activities under the conditions of ongoing conflict. There is little choice to initiate activities of immediate humanitarian need to large sections of a population, but the human and financial costs must be acknowledged and assessed on an individual, institutional, and whole-of-government basis. The SIGIR report noted that, "the lack of security threatened all capacity-development efforts. Iraqi officials often had to limit their days at the office to just two or three hours because of threats from insurgents and warring sects and the length of time it took to navigate safely the checkpoints between home and workplace. By 2007, the kidnapping and killing of capacity-development advisors when they left the Green Zone led to restrictive policies that limited contacts between Coalition and Iraqi officials, sometimes preventing interaction altogether. Raising a new system of government and endowing it with the capacity to sustain its infrastructure effectively was a never-ending challenge, one that still had not been overcome toward the end of 2008."¹⁶⁶

*6. Correcting Deficiencies: The SIGIR report notes: "The reconstruction experience in Iraq revealed deficiencies in how the U.S. government understands the dynamics of societies it seeks to influence through military and non-military means."*¹⁶⁷

This study's departure point was to argue that the post-conflict recovery—and indeed sustained peace and security—in Syria and Iraq must answer a core question: What will it take to restore basic water and electric power to the region's population after years of violent conflict have left their infrastructure in disarray? This pilot study further argues that—beyond the technical and engineering analyses of what is required to restore water and energy networks—successful assessment and rebuilding of these networks must also consider the political, socio-economic, and demographic landscapes that gave rise to water and energy resource-use and access issues in these societies in the first place.

In Iraq and Syria, natural resources that are essential to human life and economic development have been directly employed as weapons of war by belligerents on both sides of these battles, as this study has detailed. Parties to the conflict continue to target public infrastructure and facilities,

¹⁶⁵ Ibid., 331.

¹⁶⁶ Ibid., 272-273.

¹⁶⁷ Ibid., 333.

including water supply and electricity.¹⁶⁸ This has exacerbated fuel shortages and strained electric power resources, that together have resulted in electricity being only available for limited periods of time. Additionally, parts of Iraq and Syria have been impacted by the influx of hundreds of thousands of displaced by the conflict, stressing already taxed and limited water and electric power resources.

In short, as we move more deeply into the 21st Century, resources around the world are increasingly stressed by exponential population growth and by the spatially uneven impacts of climate change. In this environment, the lessons from Iraq and Syria attest to the need for a deeper understanding of the essential role of resources, their role in societal interactions, and even their militarization. This study advocates an approach that calls attention to these complexities and moves them beyond problem definition to a coordinated methodology for disaster response and post-conflict reconstruction.

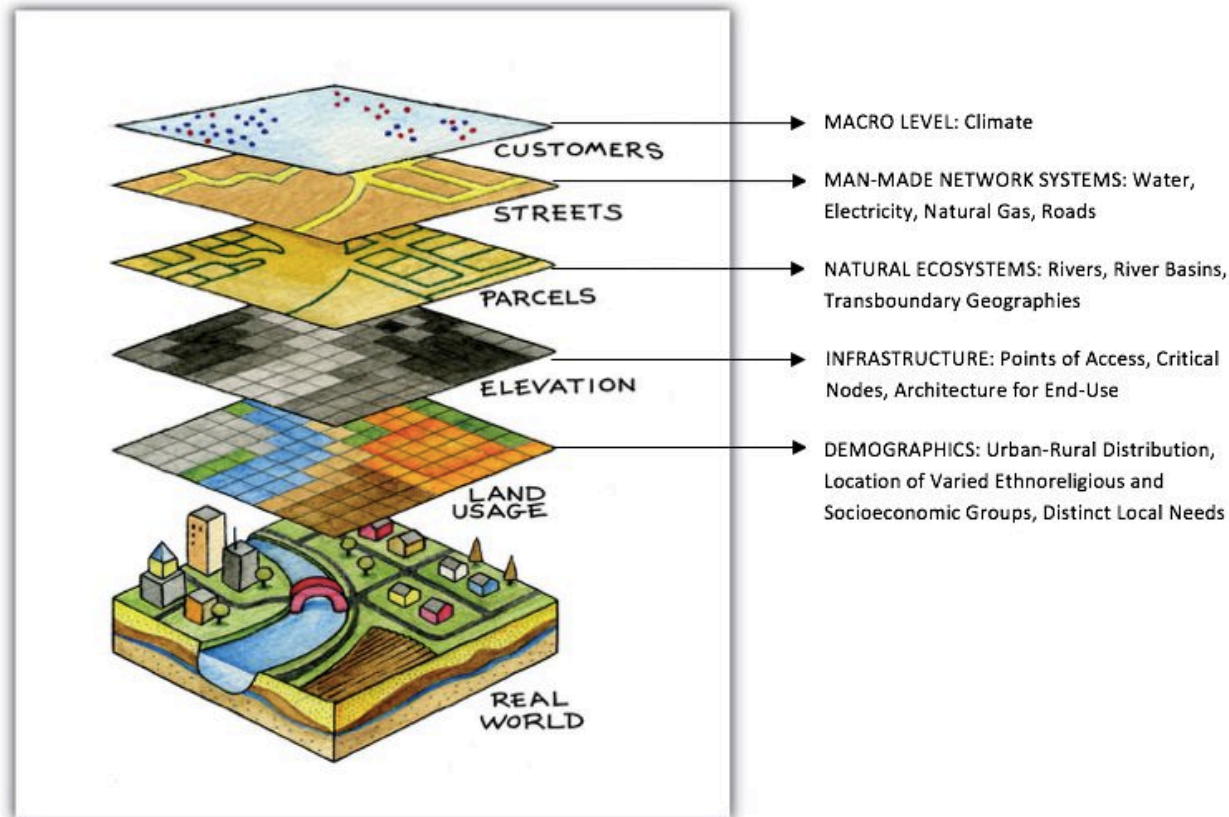
Data Acquisition and Scale

Acquiring data at the appropriate scale is central to reliably assessing water and electric power infrastructure in Iraq and Syria. Collecting data at the appropriate scale is vital not only for determining data acquisition methods but also for ensuring collection of information that decision makers can actually use in drafting policy responses that will be successful when implemented.

To this end, it is necessary to collect data both from the bottom-up and top-down in Iraq and Syria. This will produce both the granular data needed to assess human needs and the state of infrastructure at the neighborhood level, and the high-level economic, political, and environmental data needed to assess broader patterns. These various scales of data allow a stratified understanding of the challenges, barriers, and opportunities for improving water and electric power availability and their potential contribution to peace and stability in these states. Combining stratified data into an integrated framework allows policymakers to systematically identify, depict, and then assess the state of water and electric power infrastructure on primary, secondary and tertiary levels, and understanding these challenges and their interconnectedness by their constituent parts.

¹⁶⁸ For updated details on the security situation in Syria where water in particular is concerned, see for example the WASH profile maintained by ACAPS (Assessment Capacity Project) at www.acaps.org/node/194/crisis-analysis/9604/move/down.

Figure 10. Integrated security analysis framework



Source: Rosner 2016¹⁶⁹

Figure 10 shows a sample integrated security analysis framework. It may provide a convenient departure point for discussing which data to include, how to organize data collection, and how to stratify data into geographically identical grids, allowing for a multi-disciplinary analysis of findings on a localized basis.

The organizational structure of the data and the data collection methodology, if done properly, can allow for answering many questions in the water and electric power spheres in Iraq and Syria. While the organization and collection of the data may provide some complex challenges—for example in coordinating the highly granular, subnational data on climate change impacts with ethnographic data that is often tracked at the national level—a bridge can be made between these scales.

¹⁶⁹ Kevin Rosner, “Hybrid Warfare and Critical Infrastructure Protection,” unpublished manuscript, 2016. Graphic uses Microsoft Clip Art.

Analytical Scales: Primary, Secondary, Tertiary

What follows is a rather simple, practical example on how a stratified assessment model could be built using different data acquisition methods appropriate for different scales. The number of levels of analysis is unlimited, as is the number of datasets one may wish to depict. Therefore what follows is simply a working example of what could be done on hereafter what is referred to as a primary, secondary and tertiary scale moving from granular (micro) to macular (tertiary) in scope. These recommendations are by no means definitive or exhaustive but simply meant to illustrate the multi-scalar methodological approach this pilot study promotes.

Primary Analysis

Primary-level analysis is best thought of as grass-roots analysis that involves data collection on a micro level. It is the earliest or most basic level of analysis. It is largely focused on people as opposed to systems. The work of the REACH consortium provides a proof of concept for a primary-level methodology that has been used in the past and that might be employed for generating this stratification of essential water- and energy-related data. The REACH methodology—already deployed in Syria—demonstrates that such granular data collection can be done even in conflict zones.

REACH is a joint initiative of three organizations—IMPACT, a leading Geneva-based think and do tank; ACTED (Act for Change) a French NGO; and the United Nations Operational Satellite Applications Programme (UNOSAT)—created to “facilitate the development of information tools and products that enhance the humanitarian community’s decision-making and planning capacity.”¹⁷⁰ The REACH methodology is largely a household analysis carried out using mobile phones equipped with the data collection application KoBoCollect.¹⁷¹ It has been used at least twice in Syria. It was used to conduct the Eastern Aleppo Food Security and Livelihoods Household Assessment published in June 2015¹⁷² and the Eastern Aleppo Household Assessment: Water Security.¹⁷³

The REACH methodology appears well suited to generating primary-level information, and the quality of the data generated from this approach is high. Figure 10 provides examples of the kinds of primary data that would be collected through this approach, including demographic and ethnographic data.

Secondary Analysis

Secondary level of analysis assesses the public’s access to network-based systems. More often than not, these networks belong to the infrastructure category and include electric power grids,

¹⁷⁰ For more information, see the REACH website at www.reach-initiative.org/reach/about-reach.

¹⁷¹ *Ibid.*, 3-4

¹⁷² REACH, *Eastern Aleppo Food Security and Livelihoods Household Assessment* (Geneva: REACH, 2015).

¹⁷³ REACH 2015, *Eastern Aleppo Household Assessment: Water Security*.

hydro-electric facilities, and water treatment and distribution systems. The range of data and data sources could be sub-national in origin but concurrently compiled into some larger, macro-level analysis.

One proof of concept for this level of analysis is provided by the World Bank. It has developed a damage and loss assessment methodology for post-disaster financial assessments.¹⁷⁴ This methodology is described as follows:

Assessments estimate, first, the short-term government interventions required to initiate recovery and second, the financial requirements to achieve overall post-disaster recovery, reconstruction, and disaster risk management or reduction. The damage and loss assessment (DaLA) methodology uses objective, quantitative information on the value of destroyed assets and temporary production losses to estimate, first, government interventions for the short term and second, post-disaster financing needs. The DaLA method ensures that the affected government, the United Nations and other international and domestic agencies jointly develop properly estimated and prioritized financial requirements and an accompanying formula that identifies all possible financial sources and modalities.¹⁷⁵

This secondary level of assessment allows for a cumulative analysis of the lagging infrastructure and network needs impacting on individuals' and households' experiences captured by the REACH primary-level assessment. It focuses on state and private-sector financial loss and the requirements for the return of displaced people. Given the financial focus of the assessment's criteria, the application of the assessment's findings are at a broader, programmatic scale.

The DaLA methodology has been applied in Syria's conflict economy to conduct a financial assessment of physical assets for major municipalities.¹⁷⁶ However, based on the observations cited earlier from the findings of the Special Inspector General for Iraq Reconstruction, the WB/IMF assessment model clearly addresses at scale some of the outstanding needs pointed out by the SIGIR in the watershed Iraq Reconstruction reports.

Tertiary Analysis

The tertiary level of analysis adds data on natural ecosystems, man-made network systems, and macro climate systems that can be visually depicted from satellite imagery and government data. For this study, it includes visual data and assessments on natural and man-made systems related to water and energy (i) resources such as surface and ground water networks, (ii) infrastructure such as power generation, water treatment, and water storage facilities, and (iii) distribution systems such as energy transmission lines and water distribution networks. Thus while the secondary level

¹⁷⁴ Gobat and Kostial 2016.

¹⁷⁵ World Bank, *Damage, Loss, and Needs Assessment: Guidance Notes, Volume 3* (Washington: World Bank, 2014), 1.

¹⁷⁶ Ibid.

of data collection assesses the interaction between the public and water and electricity networks (specifically the public's points of access to these networks), this tertiary level of data collection assesses interactions within and across the network systems themselves.

These layered data aim to capture the entire supply chains for these two critical resources. With data at each of these levels, users can model the factors that contribute to water and energy stress, locate points in the supply chain that are most susceptible to stress, and devise policy interventions to address current and expected future stresses on these two vital systems.

The tertiary level of analysis tracks natural and man-made networks that often cross country boundaries. These data thus allow users to assess transboundary supply-and-demand, infrastructure, and technologies. This allows users to understand, model, and assess the feasibility of policies related to transboundary cooperation such as regional water-energy exchange or integrated regional development of the water and energy sectors.

Conclusion

Water is crucial to human security, electric power is fundamental to economic security, and if these assets fall into the wrong hands, this failure undermines state security. In instances where one or more of these fundamentals of society fail, people flee. They move as quickly as they can towards places that do have these resources. This has been demonstrated by the millions of IDPs in Syria fleeing conflict towards resources necessary for sustaining life. Economic activity collapses in the absence of electric power, and people flee to provide for themselves and their families, as Europe has experienced first-hand over the last 24 months. And non-state groups that gain control over both water and electric power will exploit both for their own end goals, including to undermine their host state and state security. In this last instance, violent non-state actors coerce captive populations to remain and threaten them with punishment or death if they seek to flee and escape.

A combination of complex hydrological and demographic factors are contributing to increasing water stress across the combined Euphrates-Tigris basins. Water and energy complexities include any number of issues including environmental factors such as climate change. The evidence suggests this is precisely what is happening in the Euphrates-Tigris basins where water availability has been severely cut back due to varied factors from lower upstream discharge to the growing impact of environmental factors that reduce water quantity. It is worth restating that if these climate change forecasts occur their impact on the region's political, economic, and social stability will be of a magnitude far greater than present instabilities driven by civil war and insurgency. This could make present instabilities look like round one of a much longer match than anyone anticipates. In the shorter term, if and when Syrians return to their homeland this will place a considerable burden on already heavily debilitated or destroyed water resources, networks, and systems. Establishing a baseline in understanding the state of these resources and assets is key to rapid, efficient, and cost-effective recovery for Syria's population. This can and should be done now.

On the infrastructure side of the equation, this study chose to focus on dam infrastructure. This was done for two reasons. Dams are sources of both stored water and hydroelectric power production. Control over these structures translates into control over both water and power that can be leveraged by the controlling party. Equally important as a future area of research exploration would be to catalog the location and physical state of other water facilities and critical nodes in both Syria's and Iraq's water infrastructure as these facilities are directly linked to the human security of the populations they service. Determining the importance of each system node, i.e. criticality, is central to this exercise and can certainly be ascertained by trained engineers for assessment and reconstruction purposes. Carrying out such assessments quickly and then acting upon them will be key to resuming provision of these services, bolstering the security of the population, and stabilizing the region. How much this will cost and who will pay is an inevitability to be addressed sooner rather than later.

Finally, this study spends considerable time considering the logic and movement of ISIS across Syria and Iraq particularly where water and power assets are found. This study argues that their seizure was the result of ISIS territorial expansion in the process of declaring its caliphate and was not the immediate goal of the expansion itself. The significance of this distinction is that the conflicts and struggles in Iraq and Syria are not ‘resource wars’ per se but wars in which resources are exploited by the victors to punish the vanquished. Having said this does not obviate the need to better understand how ISIS successfully seized these water and energy assets and why these assets—that are critical to the functioning of the modern state—were not better protected in the first place. This is a need presently unmet in the current literature.

Beyond the physical is a brief discussion of the social dimensions of water and electric power in Iraq and Syria. Ethnic and religious divisions are present in both societies, but a much more thorough analysis is needed to assess the degree to which water and energy resources are equitably or inequitably distributed across these groups. This study recommends a follow up study to determine the level and degree to which discriminatory policies can be mitigated and to what extent, if carried out, this would help stabilize both societies.

On electric power access and availability, this study states categorically that the electricity sectors in both Iraq and Syria reflect substantial degradation from years of conflict. Developing a remediation plan is complicated by uncertainty about the exact level of functioning of specific assets across the territories of both countries since the authorities responsible for the operation and maintenance of these assets, in many cases, cannot access areas where governmental control has been ceded to ISIS or opposition group forces. Unfortunately, this will continue to plague this sector until hostilities cease. The Iraq reconstruction experience is a testament to the human and financial costs of repairing or replacing damaged power infrastructure under the dangerous conditions of conflict.

This study further points out that electricity generation and continuity in Syria and Iraq is a function not only of the integrity of the generating facilities themselves but also of the fuel-systems on which they depend. Following this supply chain, and the critical nodes in them, is key to understanding the full set of issues and vulnerabilities associated with water and electric power in Iraq and Syria. Oil is key not only to Iraq’s but also to Syria’s economy, but its output has been declining. This raises the issue for Syria’s post-conflict electricity sector as to whether Syria’s pre-war falling oil output will be of any value to the country for generating revenue for reinvestment purposes into its electricity sector or whether this potential future revenue stream from oil exports is already committed for war reparation purposes to Russia and Iran. Similar fuel issues exist for Iraq which admittedly is in a much better position than neighboring Syria. If for example, Iraq can somehow move towards capturing natural gas that is now flared, this would avoid unnecessary natural gas imports from elsewhere like Iran, improve the country’s balance of payments, and bolster its own energy security through energy independence.

It would appear that ISIS is on the run in Iraq, and it is only a matter of time until a siege of its de facto capitol in Syria, Raqqa, commences. However, the scorched-earth policies this study explores remain a key issue. Until ISIS is vacated completely from the territory it has held, it is impossible to estimate the level of damage it has inflicted on critical water and power systems on which the population of the region depends.

The date when conflict ends and a post-conflict era begins in Iraq and Syria remains unknown—as does the political and governance setting that will rule over the region’s water and electric power infrastructure. The only present certainty is that there is a path forward that offers Iraqis and Syrians, as well as those who can bring resources to the table, tools to assess and respond to present water and power crises in these countries.

As a global community, we can be innovative in assessing many layers of data where analysis and response are needed: at the level where people live and at the levels where network systems operate. This can create a comprehensive picture of the extent of damage and degree of recovery efforts needed to bring water and electric power systems back online as quickly, equitably, and sustainably as possible. What makes this process easy and comprehensible is that most of the tools—the methodologies, technologies, and knowledge—needed to accomplish this task are available. We simply have to reorder them to accomplish the task at hand. To this end, this study proposes how a stratified assessment model using different data acquisition methodologies appropriate for different scales could be built. This is only a proposal to get us, as a community of the interested, started on working towards this end. But it is as well a call to start this process now in order to accelerate recovery in Iraq and Syria for the benefit of all Iraqis and Syrians.

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Annex. Dams in Iraq and Syria

Country	Name of dam	Administrative unit	Nearest city	River	Major basin	Completed/ Operational since	Irrigation	Water supply	Flood control	Hydroelectricity (MW)
Iraq	Ramadi-Habbaniya	Anbar	Ar Ramadi	Euphrates	Tigris / Euphrates	1951	x		x	
Iraq	Samarra	Salaheldin	Samarra	Tigris	Tigris / Euphrates	1954			x	
Iraq	Sennscherib	Ninevah	Tal Afar	Tigris	Tigris / Euphrates					
Iraq	Thartar	Salaheldin	Ar Ramadi		Tigris / Euphrates		x			
Iraq	Buhayrat Dihok	Dahuk	Dihok		Tigris / Euphrates					
Iraq	Al Adhaim	Salaheldin	Samarra	Adhaim	Tigris / Euphrates		x		x	x
Iraq	Al Kut	Wasit	Al Kut		Tigris / Euphrates					
Iraq	Dokan	As Sulaymaniyah	Dukan	Lesser Zab	Tigris / Euphrates	1961	x			
Iraq	Derbendi Khan	As Sulaymaniyah	Ba'qubah	Diyola river	Tigris / Euphrates	1962	x			
Iraq	Dibbis	Ta'meem	Buyak Hisar	Lesser Zab	Tigris / Euphrates	1965	x			
Iraq	Raza Dyke	Kerbala	Kerbala		Tigris / Euphrates	1970				
Iraq	Hamrin	Diala	Ba'qubah	Diyola river	Tigris / Euphrates	1980				
Iraq	Mosul	Ninevah	Mosul	Tigris	Tigris / Euphrates	1983	x			x
Iraq	Haditha	Anbar	Islamiyah		Tigris / Euphrates	1984	x			x
Iraq	Fallujah	Anbar	Fallujah	Euphrates	Tigris / Euphrates	1985	x			
Iraq	Al Hindiyah	Babil	Al Musayyib		Tigris / Euphrates	1989			x	
Syrian Arab Republic	Al Rastan	Homs	Homs	Asi-Orontes	Asi-Orontes	1960	x			
Syrian Arab Republic	Mhardeh		Hama		Asi-Orontes	1960	x			
Syrian Arab Republic	Al-Dumair		Damascus		Barada & Awaj	1966				
Syrian Arab Republic	Karimeh		Al-Hasskeh		Dajleh & Khabour Basin	1967				
Syrian Arab Republic	Al-Shahba		Aleppo		Asi-Orontes	1968				

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Syrian Arab Republic	Abou-Keleh		Homs		Desert Basin	1968				
Syrian Arab Republic	Al- Waer		Deir.ez.zor		Desert Basin	1968				
Syrian Arab Republic	Al-Kalamown		Damascus		Barada & Awaj	1969				
Syrian Arab Republic	Wady-Al-Karn	Damascus			Barada & Awaj	1969				
Syrian Arab Republic	Al-Kafat		Hama		Asi-Orontes	1969				
Syrian Arab Republic	Dar'a Eeast		Dara		Alyarmouk basin	1970				
Syrian Arab Republic	Al-Kariatain		Homs		Desert Basin	1970				
Syrian Arab Republic	Al-Marba		Homs		Desert Basin	1970				
Syrian Arab Republic	Ibta'a Alkabir		Dara		Dajleh & Khabour Basin	1972				
Syrian Arab Republic	Al Tabqa	Raqqa	Raqqa	Euphrates	Euphrates	1973	x			x
Syrian Arab Republic	Bab AL-Hadid		Al-Hasskeh		Dajleh & Khabour Basin	1973				
Syrian Arab Republic	Al-Jawadia		Al-Hasskeh		Dajleh & Khabour Basin	1974				
Syrian Arab Republic	Al-Heffeh		Lattakia		Coastal Basin	1975				
Syrian Arab Republic	Taldo		Homs			1975				
Syrian Arab Republic	Qattinah	Homs	Homs	Asi-Orontes	Asi-Orontes	1976	x			
Syrian Arab Republic	Room Jwailin		Swaida		Dajleh & Khabour Basin	1977				
Syrian Arab Republic	Belloran		Lattakia		Coastal Basin	1978				
Syrian Arab Republic	Jabl Al-Arab		Swida		Dajleh & Khabour Basin	1978				

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Syrian Arab Republic	Darattia		Damascus		Barada & Awaj	1980				
Syrian Arab Republic	Kara-West		Damascus		Barada & Awaj	1980				
Syrian Arab Republic	Habraan		Swaida		Dajleh & Khabour Basin	1980				
Syrian Arab Republic	Tanonoh		Homs		Asi-Orontes	1980				
Syrian Arab Republic	Al-Joraji		Al-Hasskeh		Dajleh & Khabour Basin	1980				
Syrian Arab Republic	Maashoaue		Al-Hasskeh		Dajleh & Khabour Basin	1980				
Syrian Arab Republic	Rajo		Aleppo		Asi-Orontes	1981				
Syrian Arab Republic	Kafer Debail		Lattakia		Coastal Basin	1982				
Syrian Arab Republic	Al-Gazieh Sharkieh		Dara		Alyarmouk basin	1982				
Syrian Arab Republic	Alshikh Mis-kin		Dara		Alyarmouk basin	1982				
Syrian Arab Republic	Gharbi Tefas		Dara		Dajleh & Khabour Basin	1982				
Syrian Arab Republic	Tasil		Dara		Alyarmouk basin	1982				
Syrian Arab Republic	Al-Khsahabia		Hama		Desert Basin	1983				
Syrian Arab Republic	Al-Mansoura		Al-Hasskeh		Dajleh & Khabour Basin	1983				
Syrian Arab Republic	Al-Saffan		Al-Hasskeh		Dajleh & Khabour Basin	1983				
Syrian Arab Republic	Al-Hakmieh		Al-Hasskeh		Dajleh & Khabour Basin	1984				
Syrian Arab Republic	Al-Kabir Ashmali		Lattakia		Coastal Basin	1985				
Syrian Arab Republic	Kaliefeh		Tartous		Coastal Basin	1985				
Syrian Arab Republic	Al-Zolaf		Swaida		Dajleh & Khabour Basin	1985				
Syrian Arab Republic	Al-Houyes		Lattakia		Coastal Basin	1986				
Syrian Arab Republic	Sallah Addin		Lattakia		Coastal Basin	1986				
Syrian Arab Republic	Odwan		Dara		Alyarmouk basin	1986				
Syrian Arab Republic	Sahwat alkhdar		Swaida		Dajleh & Khabour Basin	1986				
Syrian Arab Republic	Biet-Al-rehan		Lattakia		Coastal Basin	1987				

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Syrian Arab Republic	Ghadeer al-bostan		Quneitra		Dajleh & Khabour Basin	1987				
Syrian Arab Republic	Abou Baara	Hama	Hama		Asi-Orontes	1987				
Syrian Arab Republic	Al-Khassania		Hama		Asi-Orontes	1987				
Syrian Arab Republic	Wadi Albid		Homs		Desert Basin	1987				
Syrian Arab Republic	Abdeen		Dara		Alyarmouk basin	1989				
Syrian Arab Republic	Al-Kanawat		Swaida		Dajleh & Khabour Basin	1989				
Syrian Arab Republic	Al-Taiba		Swaida		Dajleh & Khabour Basin	1989				
Syrian Arab Republic	Al-Baath		Al Rakka		Euphrates	1989				
Syrian Arab Republic	Alillan		Dara		Alyarmouk basin	1990				
Syrian Arab Republic	7 Th.OfApril		Al-Hasskeh		Dajleh & Khabour Basin	1990				
Syrian Arab Republic	8 Th.OfMarch		Al-Hasskeh		Dajleh & Khabour Basin	1990				
Syrian Arab Republic	Kafer Roheen		Idleb		Asi-Orontes	1991				
Syrian Arab Republic	Al-Hessiat		Hama		Desert Basin	1991				
Syrian Arab Republic	Rabet-Al-shek		Hama		Asi-Orontes	1991				
Syrian Arab Republic	Bhmra		Lattakia		Coastal Basin	1992				
Syrian Arab Republic	Kastoun		Hama		Asi-Orontes	1992	x			
Syrian Arab Republic	Salhab		Hama		Asi-Orontes	1992				
Syrian Arab Republic	Al-Muaizelieh		Deir.ez.zor		Desert Basin	1992				
Syrian Arab Republic	Kodna		Quneitra		Dajleh & Khabour Basin	1995				
Syrian Arab Republic	Sahem AlJoulan		Dara		Alyarmouk basin	1995				
Syrian Arab Republic	Al Douaysat		Idleb		Asi-Orontes	1995				
Syrian Arab Republic	Zeyzoun	Hama			Asi-Orontes	1995	x			
Syrian Arab Republic	Al-thoura		Lattakia		Coastal Basin	1996				
Syrian Arab Republic	Afamia /1/		Hama		Asi-Orontes	1998				

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Syrian Arab Republic	Tal Houshe		Tartous		Coastal Basin	1999				
Syrian Arab Republic	Tishrin	Aleppo	Aleppo		Euphrates	1999				x
Syrian Arab Republic	Martyr Basel AL-Asad		Tartous		Coastal Basin	2000				
Syrian Arab Republic	Kazan-Al-Bala		Idleb		Asi-Orontes	2001				
Syrian Arab Republic	Khabour		Al-Hasskeh		Dajleh & Khabour Basin	2001				
Syrian Arab Republic	Al-Mazyne		Tartous		Coastal Basin	2003				
Syrian Arab Republic	Unity (Wadha)	Irbid	Dara	Yarmouk River	Yarmouk	2007	x	x	x	x

Source: FAO 2009



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