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A Water and Energy Nexus as a Catalyst for Middle East Peace

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Regional trade agreements in Europe over coal and steel served as the foundation for both larger regional integration and regional stability. A water-energy nexus could provide a similar foundation for a more peaceful and more sustainable Levant region. The Levant is among the most water stressed regions in the world, but it is bountiful in solar energy potential. Technological innovation coupled with transboundary cooperation could provide the solution to the region's growing water and associated energy demand, as well as contribute to regional stabilization. This paper explores the rational for the creation of a proposed water-renewable energy community based on interdependence among Israel, Jordan, and Palestine, where much needed water is produced through desalination on the Israeli and Palestinian Mediterranean coasts and additional electricity needs are met by extensive investment in solar renewable energy in Jordan's eastern deserts.

Keywords: Water-energy nexus, Environmental peacebuilding, Resource trade, International agreements, Israel, Jordan, Palestine

1. Introduction

Resource-conflict theory maintains that countries with a scarcity of renewable resources, such as agricultural land, water, fisheries, and forests, are more likely to engage in conflict. Countless theoretical papers and empirical studies have demonstrated that shortage of these vital resources is enough to prompt (violent) conflict among those that share the resource (*EU-UN*, 2012; Homer-Dixon, 1994; Maxwell and Reuveny, 2000). But, the field of environmental peacebuilding asserts otherwise, demonstrating that mutual concern and interest in shared resources can instead serve as a means for cooperation.[1]

[1] The United Nations Environment Programme (UNEP) refers to this as environmental diplomacy ("Environmental Cooperation").

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The environment is unique in its ability to unite people—even people from traditionally adverse backgrounds—in a way that other (political) issues cannot. First, the environment is universal: environmental problems transcend social barriers and socioeconomic groups and therefore serve as a common ground for people from diverse backgrounds (Jacobs, 2002; Swain, 1997). Second, the environment ignores political borders. In the same way that the environment can bring together people from different ethnic groups and socioeconomic classes, it can also bring together people from different countries, even political adversaries: "Initiatives [around] common ecological problems can be used to bring about an initial dialogue between the parties to a conflict when other political and diplomatic approaches have failed" (Carius, 2006: 7; Dabelko, 2006). Furthermore, environmental problems that transcend political boundaries cannot be solved unilaterally, and instead require transboundary cooperation (Dabelko, 2006). Third, the environment is typically considered a politically "safe" issue; it is possible to address environmental problems in greater isolation from other issues of political tension (Tullius, 1997). In some instances, the environment may be a matter of "high politics" (Lowi, 1995), but, even then, environmental issues can still be considered low-hanging fruit, a problem that is comparatively easy to address and that can provide a first step for engaging in dialogue before addressing larger, more politically challenging issues (Dabelko, 2006; Harari, 2008). Fourth, environmental problems almost always require long-term solutions; there are no quick fixes. Addressing these issues therefore requires long-term cooperation, creating a platform for *ongoing* dialogue that can help build trust between adverse parties (Dabelko, 2006; Harari, 2008). And fifth, given the ways in which the environment can bring even historic adversaries together, cooperative endeavors over environmental issues can help lead to the formation of other post-conflict reconstruction or can even help broker a larger peace agreement (Dabelko, 2006).[2]

Freshwater resources have demonstrated the ways in which even politically adverse countries can cooperate over environmental problems. And, contrary to the theory of resource scarcity, it has been found that, at least at an international scale, the shortage of shared freshwater resources is more likely to prompt cooperation and negotiation between countries than it is to promote conflict (Hauge and Ellingsen, 1998; Hendrix and Glaser, 2007; Homer-Dixon, 1994; de Soysa, 2002; Urdal, 2005). International cooperation over water resources far outweighs incidents of armed conflict: in the past 1,200 years, riparian nations have signed over 3,600 international treaties over the use of their shared water resources (Hamner and Wolf, 1998). Although the majority of treaties address the rights of use for each country (usually for navigational or fishing purposes), a significant number address more complex issues, including distributing shared benefits from the construction

[2] For example, joint management of a rainforest shared by Peru and Ecuador was instrumental in brokering a peace agreement between the two countries. The border between Peru and Ecuador had been a site of territorial conflicts since the end of Spanish rule. The Acta Presidencial de Brasilia signed by both countries resolved the border conflict by establishing joint management structures and the Cordillera del Condor Transboundary Park, a protected zone for conservation on either side of the disputed border, which "created a space for cooperation between both countries and ultimately led to bi-national initiatives" (Alcalde, Ponce and Curonisy; Dabelko, 2006; ITTO et al., 2000, as cited in Alcalde, Ponce and Curonis).

of large infrastructure projects, such as electricity and storage for irrigation water from dams (Hamner and Wolf, 1998; International Freshwater Treaties Database). Furthermore, water agreements are unique with respect to their resiliency: countries continue to adhere to the terms of the treaty, even in times of conflict (Wolf, Yoffe, and Giordano, 2003).[3]

However, almost all water treaties concern only natural, surface water resources. Can, then, non-traditional water resources and non-traditional water trade agreements promote the same long-term cooperation and stability that past water agreements have? This paper examines the rational and the need for further in depth investigation of the economic, technical, and geopolitical feasibility for advancing a cooperative framework that would result from a unique produced water- renewable energy trade agreement between Israel, Palestine, and Jordan, one that would not only promote stable and sustainable regional trade in water and energy, but regional interdependence, as well, in the hope of providing a foundation for larger regional unification, helping to foster regional stability.

2. Background: Comparison of Resource Trade Agreements

Natural resources, including international freshwater resources, have been at the center of many trade agreements, some of which have led to larger regional cooperation. These agreements function on the idea of competitive advantage, in which countries agree to trade goods or provide services for the resource they are more equipped to produce in exchange for those that they lack. These agreements can manifest in several ways, including as an exchange of services or as an exchange of the goods themselves, either as a means of compensation or as a way to promote greater interdependence. Although many of these agreements have been stable and long-lasting, only those promoting regional *interdependence* have contributed to efforts that have brought about larger regional unification.

Turkey and Iraq represent a unique example of water and energy trade agreements. Each country is wealthy in one resource with respect to the other—Turkey in water resources and Iraq in hydrocarbons—and through both formal and informal agreements these countries have agreed to grant the other access to their respective resource. Their trade agreements demonstrate that regional cooperation can be accomplished by means other than an exchange of the goods themselves; mutual benefit can be gained by sharing services.

In 2008 Turkey and Iraq established a "long term Strategic Partnership with the aim of enhancing solidarity between Turkish and Iraqi peoples" (*Joint Declaration between Turkey and Iraq*, 2008). Its goal is to foster international cooperation in energy and water,

[3] What makes many water treaties robust is the mechanisms that have been included to manage disputes (Jacobson and Weiss, 1998, as cited in Zawahri, Dinar and Nigatu, 2013). Resiliency is seen as ability to adapt to (hydraulic) stress or changing conditions (Zentner, 2012). Flexibility to adapt to changing circumstances, ability to enforce adherence to the treaty, and established communication networks among parties (for data sharing, dispute resolution, etc.) are included in many treaties to minimize stress caused by changing conditions, and thereby create a lasting treaty (Zentner, 2012).

among other political and cultural issues. In line with the Strategic Partnership, Turkey and Iraq have since engaged in several cooperative agreements over water and energy resources, which have each, in their own way, been aimed at fostering peace in the region. With regard to water resources, in 2009 Turkey agreed to release more water to Iraq in exchange for Iraq's cooperation in cracking down on Kurdish rebels near the Turkish border. Regarding energy resources, Iraq has vast resources of hydrocarbons, but Turkey surpasses Iraq in infrastructure and technical know-how necessary for the development of these resources ("Relations between Turkey and Iraq," 2011). In 2010, Iraq awarded contracts to several Turkish petroleum companies to develop the Iraqi natural gas fields, which has helped foster "increasing interdependence" between the two countries (Turunc, 2011: 42).

Other agreements, such as over the construction of large-scale infrastructure projects, can promote a trade of goods as a means to reap mutual benefits in compensation for development. This type of agreement encompasses the construction of hydroelectric dams along international rivers in which the two (or more) countries agree to cooperate over the development of electricity and water resources.

According to Wolf (1998) dams can be a good example of shared interest projects that can benefit both riparians: upstream countries nearer to the headwaters usually have better geographic conditions for a dam sight, while downstream countries usually have better agricultural lands that would benefit from the regulation of the flow of the river. The construction of a hydroelectric dam can benefit all parties by generating electricity, creating a source of water for irrigation, and managing flood control. Ninety treaties over hydroelectric dams have been signed since 1820, though not all of them explicitly address an exchange of the produced goods (International Freshwater Treaties Database).

One example that does address such an exchange is the water-energy trade agreements between India and Nepal. India and Nepal have several agreements over hydropower, dating back as far as the 1950s. The major ones—the Koshi Agreement and the Gandak Agreement—are fairly similar in content. Both agree to the construction of a hydroelectric dam for the purpose of flood control (for India's benefit) and for electricity generation and storage of irrigation water (for Nepal's benefit) (Saurabh, 2012). In addition to negotiating water allocations, the agreements also stipulate that India would help provide electricity to Nepal either by building hydroelectric power plants in Nepal or by constructing plants in India from which Nepal could purchase a certain percentage at production cost (*Independent Power Producers*, 2006; Saurabh, 2012).

However, the downside of creating shared benefits, including benefits gained from "shared" services—as opposed to interdependence—is that a system of shared benefits tends to give one party the upper hand. For example, in an upstream-downstream riparian scenario, the upstream country (usually the country with the dam) has control over the flow of water—they can induce floods or droughts downstream if they so choose—and the downstream country, unless it is a larger military power, effectually becomes dependent on the goodwill of the upstream neighbor. Although a treaty solidifies mutually agreed-to terms, to some degree the maintenance of the treaty depends largely on only one country (in this example, the upstream country with the dam).

The current relations between Turkey and Iraq demonstrate well the shortcomings of a system of just shared benefits. Although Turkey is interested in accessing the Iraqi natural gas fields, it is by no means economically or energy dependent on gaining access to these resources. Turkey is becoming a major energy hub, connecting the energy markets of Russia, Europe, the Middle East, and the Caspian region, and the vast majority of its oil and natural gas imports come from countries other than Iraq (*EIA* "Turkey," 2014). Furthermore, to the dismay of the Iraqi government, Turkey is establishing a deal with the Iraqi Kurds in order to gain access to some of the Iraqi natural gas reserves (Arango and Krauss, 2013). Lacking an agreement that makes the two countries equally dependent on the other has effectually given Turkey a significant upper hand: Turkey controls the flow of water and, through its deal with the Kurds, is also gaining access to Iraqi natural gas reserves. Strictly regarding trade relations, Turkey's developments with the Kurds has effectually created a condition where Turkey has little to lose from breaking or undermining its 2008 and 2009 trade agreements with Iraq; Iraq, on the other hand, stands to lose a lot.

In contrast, treaties that foster interdependence are thought to be more robust settlements. Interdependence is a condition where two or more entities are each *dependent* on the other(s) for the products that they themselves cannot efficiently produce, in exchange for items they themselves produce efficiently. A shared benefits situation may require initial interdependence (such as in the funding and construction of a dam), but once the infrastructure is in place, countries may be able to function unilaterally (as mentioned earlier in the case of an upstream country with a dam). In contrast, interdependence requires *continued* reliance on the other in order to produce the mutually beneficial end product(s).

Agreements promoting interdependence can also serve as strong stepping stones for larger peacebuilding efforts as they require a significant amount of trust and long-term cooperation. The European Coal and Steel Community (ECSC) is an early example of an agreement where resource interdependence helped foster larger regional unification. The ECSC was established in 1952 to integrate coal and steel industries across Western Europe and was created with the intention of establishing a common economic community in order to make strong connections among historic political adversaries (*Treaty European Coal and Steel Community*, 1951).

Although the ECSC never successfully built a common market for coal and steel,[4] it was seen as an instrumental stepping stone for integrating the economies of Europe (Alter and Steinberg, 2007): it convinced European countries to delegate part of their national sovereignty to an international body that was responsible for making decisions in the interest of the member states (Toepke, 1981). The ECSC's most important contribution, then, is that it encouraged other, more successful attempts at integrating the economies of Europe, including the creation of the European Economic Community (EEC), which created a common market for goods other than coal and steel (SEA, 1987; Shenoy, 2012;

[4] Soon after the creation of the ECSC changing market conditions essentially erased the problems the ECSC was set up to address: there was a surplus of steel in the market and technological advances made it easier to acquire coal from non-European markets (Alter and Steinberg, 2007).

Toepke, 1981). The EEC later joined with two other pan-European communities to form the European Community (EC), which in turn was responsible for passing the Single European Act (SEA), which sought to add new momentum to the integration of the internal European market (SEA, 1987). The subsequent success of SEA encouraged EC Member States to push for further reforms toward European integration. This process culminated with the Treaty of Maastricht, which created the European Union (*Treaty of Maastricht*, 1992). Thus, although the ECSC by no means led directly to the creation of the European Union—a pinnacle example of regional integration—the ECSC was a necessary first step to kick-start the unification process.

If regional trade agreements over resources in Europe could lead to the eventual unification of much of Europe, then perhaps a similar agreement—one that fosters regional interdependence—can kick-start a process of larger regional cooperation, and perhaps even regional unification, in the Levant region (and that in the more distant future could even include Lebanon and the Egyptian Sinai). The creation of a proposed water-energy trade community (*discussed in more detail below*) builds off the precedent of regional integration set by the ECSC. It suggests integrating the energy and water production sectors of Jordan, Israel, and Palestine in order to produce enough water to meet the growing needs of the region, overtime replacing the current dominance of fossil fuels with renewable energy as a key source of electricity.

3. The Proposal

Israel has already invested heavily in desalination along its Mediterranean coast. Yet producing and pumping water for desalination and wastewater treatment presently consumes about 10% of Israel's electricity supply (Dolev et al., 2013). Electricity production in Israel is overwhelmingly dependent on the burning of fossil fuels, with increasing reliance on natural gas ("Electricity Generation"). However, Israel's domestic natural gas supplies are estimated to last only 30-40 years (*U.S. Commercial Service,* 2014). Similarly, in Palestine, there is potential to desalinate large quantities of seawater along the Mediterranean coast of the Gaza Strip. Gaza, too, has gas reserves off its coast and while the natural gas could be an independent Palestinian source of energy that could power desalination facilities in Gaza, here, too, the natural gas will run out in a few decades. Conversely, Jordan, one of the most water stressed countries in the world, has a limited ability to expand its freshwater supply (Grover, Darwish and Deutsch, 2010). But, unlike Israel and Palestine, which have very limited reserves of available open spaces, Jordan has vast open space in the eastern desert adequate for solar energy production. Therefore, given the strengths of each country, a mutually beneficial trade is possible: in exchange for water, Jordan could supply renewable energy to power desalination in Israel and Palestine, which would increase the supply of water to Jordan, Israel, and Palestine.

Climate change is expected to exacerbate regional water problems, and, therefore, a solution that mitigates and adapts to climate change is called for (Sowers, Vengosh and Weinthal, 2011). This proposal to integrate water and renewable energy resources (still in its initial phases) could provide the solution. Furthermore, given that a produced water-renewable energy community would require long-term, continuous cooperation, it is possible that such an agreement could act as a stepping stone for larger regional integration and stability.

4. A Clear Need for Interdependent Regional Cooperation

Israel, Jordan, and Palestine are scarce in natural water resources by world standards. In order to meet the growing demand, all three countries are turning to unconventional sources of water. Israel increasingly relies on produced water, incorporating desalinated water into its potable water supply and reusing treated wastewater in agricultural irrigation ("Israel is a World Leader"; "National Water System"; "Water Sources"). Jordan is a leader in the reuse of treated wastewater in the Arab world (ACWUA, 2010: 33), and Palestine, with assistance from the donor community, is investing heavily in building wastewater treatment plants that could replace the use of freshwater in agricultural irrigation. In addition, Jordan is planning to build a desalination plant in Aqaba as part of an existing water trade agreement with Israel, and the World Bank is leading the efforts to build a desalination plant in Gaza. However, the production of these unconventional water resources is highly energy intensive. There is clearly a need to resolve these *regional* problems, and a solution that promotes regional *interdependence*, providing a source of both water and energy in a secure and reliable manner, can benefit all parties, in perhaps more than one way.

The current agenda, however, does not promote regional interdependence. A Memorandum of Understanding (MoU) focusing on water trade was signed in 2013 by Israel, Jordan, and Palestine ("Israeli Minister," 2013). This act clearly demonstrates a willingness for and exemplifies the benefits of regional cooperation. However, the water exchange is only one of partial interdependence between Israel and Jordan and it perpetuates conditions of dependence in Israeli-Palestinian relations. With regard to Israel and Jordan, the MoU proposes to build an 80MCM seawater desalination plant in Aqaba that would supply about 30MCM to Aqaba and the surrounding areas and sell the remainder to Israel to supply Eilat and the nearby Arava Valley. In exchange, Israel would sell an equivalent amount of natural water (about 50MCM) from the Sea of Galilee to Jordan using existing infrastructure to supply much needed water to the Jordanian capital (Amman). From an economic and infrastructure-based perspective the water trade is a win-win for both sides. Israel gets more water in the south without having to invest enormous sums in expanding the reach of the National Water Carrier and does not have to build a desalination plant in Eilat, which would require sacrificing beachfront valuable for the tourist industry. And Jordan buys relatively cheap water from the Israeli Sea of Galilee using existing infrastructure (bringing desalinated water from Aqaba to Amman would require a huge investment in new infrastructure and would come at enormous cost to the economy and Jordanian consumer). However, while the plan meets the water needs in southern Israel, it fails to meet the needs of northern Jordan. But, due to geopolitical considerations and public opinion in Jordan against cooperation with Israel, Jordan is reluctant to buy larger quantities of water from Israel (there is perhaps concern that increased dependency on water could be used by Israel as a political tool to gain political favor on other geopolitical matters). ("Israeli Minister," 2013).

The MoU also agreed that Israel would sell an additional 30MCM of desalinated water produced in Israel to the Palestinian Water Authority in the West Bank. Unlike the Jordanian-Israeli aspects of the MoU that speaks to limited aspects of interdependence, the Israeli-Palestinian deal only increases Palestinian dependency on water from Israel. The fear on the Palestinian side is that the continued sale of water from Israel to Palestine enables Israel to continue to ignore the need to share more fairly natural waters shared between Israel and Palestine, from which Israel currently takes the lion share. The Israeli-Palestinian aspect of the MoU has not been advanced as it highlights the pitfall of a unilateral water trade that continues to ignore the underlying politics of the region's water issues. ("Israeli Minister," 2013).

Therefore, in order to solve the water crisis sustainably and in a manner acceptable to all parties, dependency and domination must give way to interdependency and regional cooperation.

4.1. Demonstrated need: water scarcity and technology as a potential game changer

The Middle East is one of the most water stressed regions in the world. While the Middle East-North Africa regions host 5% of the world's population, they contain only 1% of the world's freshwater resources (Hussein, 2011). Massive population growth, rapid urbanization, climate change, and a surge in irrigated agriculture in the past few decades have only served to exacerbate the water scarcity problem (Allan, 1994; Alterman and Dziuban, 2010; Roudi-Fahimi, Creel and De Souza, 2002; Sowers, Vengosh and Weinthal, 2011). Furthermore, many of the regions' freshwater resources are located in transboundary basins, which has been both damaging to surface- and groundwater resources and has historically been a source of contention among riparian neighbors.

Jordan is among the most water poor countries in the world, with average annual per capita availability at a mere 145m^3/year, well below the World Health Organization (WHO) water poverty line (500 m^3/year) (Raddad, 2005; "Water for Life," 2009). With a largely arid climate (over 90% of Jordan receives fewer than 200mm of precipitation a year), freshwater resources are precious (Raddad, 2005). Jordan relies heavily on its (shared) natural water resources. While many *wadis* have been dammed to collect flood-waters, Jordan's main sources of surface water—the Zarqa and Yarmouk Rivers—are either heavily polluted or shared with neighbors (Israel and Syria on the Yarmouk) (Al-Zboon and Al-Suhaili, 2009). In addition, Jordan's groundwater resources are over-exploited, exceeding the available renewable supplies and degrading the water quality (*FAO*, 2009; Raddad, 2005). Furthermore, the influx of hundreds of thousands (perhaps over a million) Syrian refugees into Jordan are significantly increasing the country's water demand and are adding to the strain of Jordan's already chronic water shortage (Al-Khalidi, 2014; Baker, 2013).

In Palestine, restricted access due to Israeli occupation of the West Bank and pollution and over-exploitation of the Coastal Aquifer are contributing to the water shortage felt by Palestinians. In the West Bank, restricted accessibility to surface and groundwater resources is creating an engineered water shortage for West Bank Palestinians. Palestinians require Israeli permits for the construction and maintenance of water wells and wastewater treatment plants (a policy implemented de facto throughout the West Bank) (El-Jazairi, 2008; United Nations Economic and Social Commission for Western Asia & Bundesanstalt für Geowissenschaften und Rohstoffe, 2013). Although 17 licenses have been granted for well development since 1996,[5] due to political constraints—including the restriction of movement and access to construction material, something which is beyond Palestinian control—and geographical complexities, very few of the licensed wells have actually been constructed (World Bank Report). With declining water tables in both springs and aquifers and a restricted ability to adapt to changing conditions, West Bank Palestinians are increasingly dependent on water purchased from Mekorot, the Israeli water company (United Nations Economic and Social Commission for Western Asia & Bundesanstalt für Geowissenschaften und Rohstoffe, 2013). In Gaza, physical water shortage and deteriorating water quality poses a greater problem. With no perennial streams and little rainfall, Gaza relies almost entirely on water from the Coastal Aquifer (*PWA,* 2011; "Gaza in 2020," 2012).[6] Withdrawals—about three times higher than the renewable water supply—are not only depleting the available freshwater, but are causing salinization of the aquifer. Salinity is now well above WHO guidelines for safe drinking water, and nitrate pollution from sewage and agriculture (both surface runoff and underground drainage) infiltrates into the aquifer, making 90% of the aquifer unsafe to drink without treatment ("Gaza in 2020," 2012). The Palestinian Water Authority sees seawater desalination and the expansion of wastewater treatment facilities as a way to alleviate these problems (*PWA*, 2011).

Israel has made herself an exception to the widespread regional water scarcity. In response to troubling natural water shortages,[7] Israel has made significant investments in moving toward a produced water economy, relying on desalination and the reuse of treated wastewater to supplement its declining supply of natural freshwater. Israel currently has the capacity to produce 510MCM of desalinated water per year (Bar-Eli, 2014); by 2030, seawater desalination capacity is expected to be 600MCM per year (Zeida, 2014). Israel also relies heavily on the reuse of treated wastewater for agricultural irrigation. A world leader in wastewater treatment, Israel currently treats and reuses 80% of its wastewater

[5] As of 2009, 85 applications were still pending.
[6] A small amount of freshwater (4.7MCM/year) is imported from Israel (*PWA,* 2011: 3).
[7] Israel's natural freshwater resources are overstressed. Extreme drought is causing declining water levels in the Sea of Galilee, forcing Israel to increase dependence (temporarily) on desalinated water (Dvorin, 2014). The Coastal Aquifer under Israel and Gaza is over-exploited, leading to declining water tables and increasing salinity ("Gaza in 2020," 2012). The situation is particularly dire in the Gaza Costal Aquifer where salinity levels have risen well above the drinking water safety guidelines set by the World Health Organization and where 90% of the water not potable without treatment (Al-Yaqubi, 2006; *United Nations*, 2012).

(the highest rate in the world), which accounts for 18% of the country's total water supply (Dolev et al., 2013; "Israel is a World Leader").

Israel's strategic move toward a produced water economy is a significant potential game changer. As Israel lessens its dependence on natural sources of water, Israel's shift toward a produced water economy should make it more feasible to reach an agreement over shared water resources with Palestine (Brooks and Trottier, 2010).

4.2. Unsustainable energy dependence

Jordan, Palestine, and Israel are highly dependent on hydrocarbons for electricity generation, water transportation, and seawater desalination. Although Israel is the region's largest petroleum consumer (and therefore a large importer of petroleum), it is a major regional producer of natural gas, supplying most of its domestic needs in the last decade (*EIA* "Eastern Mediterranean," 2013). Israel relies almost entirely on natural gas for desalination, as natural gas is currently a cheaper and more "climate-friendly" fuel source than either oil or coal (Tenne, 2010). However, this partial energy security in natural gas is not projected for the long-term as even the Leviathan gas field, Israel's largest natural gas resource, has a lifespan of only 30-40 years (*U.S. Commercial Service,* 2014).

Jordan's current energy supplies are much more volatile. Jordan imports 96% of the oil and natural gas that it uses at a huge burden to the economy, costing between 20% and 40% of its annual GDP (*EIA* "Jordan," 2013; Hartoqa, 2007). Fuel pipelines connect Jordan to its hydrocarbon suppliers (e.g., the natural gas pipeline from Egypt), although, more recently, the supply has been unstable as a result of unrest in Syria and the Sinai. Furthermore, this energy dependence poses a national security concern. Jordan's fuel imports are bought at market price, which is both volatile and has been increasing in recent years, leading to rising electricity and fuel costs and, in some cases, even causing social unrest (Halasa, 2010; Rudoren, 2012). Jordan does have small natural gas reserves, but not enough to meet the country's needs, and the country's large oil shale reserves are not currently exploited (Energy Charter, 2010; Halasa, 2010).[8]

In Palestine, the West Bank is almost completely dependent on electricity imports from Israel, with only the Jericho region purchasing small amounts of electricity from Jordan (*World Bank,* 2007). With regard to Gaza, the problem is especially acute following the latest Israel-Hamas war where, once again, the Gaza Strip's only power station was damaged and further removed from operation, and is awaiting repairs (Sherwood, 2014). Even prior to this last war, Gaza is totally dependent on fuel imports and has a dramatic deficiency of energy supplies. Gaza imports electricity from both Israel and Egypt and, prior to the 2014 war, was generating some electricity from a single power plant (Eran, Bromberg and Milner, 2014). However, this supply only met 46% of estimated total

[8] Following the finds of large natural gas reserves off the Israeli coast, natural gas trade deals were recently signed between the Israeli producers of the Tamar natural gas field and the Jordanian Arab Potash Company and Jordan Bromine, creating a precedent for Israeli-Jordanian energy trade, even though the deal is relatively small scale and between private businesses (Solomon and Lakshmanan, 2014; Udasin, 2014b).

demand. Gaza lacks a sufficient supply of energy to meet current demands, let alone those that would be required to build a large scale desalination facility as is currently proposed by the Palestinian Water Authority (*PWA*, 2011).

4.3. Arguments against unilateral development: comparative advantage

Israel, Palestine, and Jordan have each, independently, made commitments to expand both desalination and renewable energy capacity in their own territories.[9] However, the development of a transboundary exchange is an opportunity for mutual gain and regional cooperation. Not only would this type of project promote "strategic stability" in the region (*see next section*), but it is mutually beneficial from a practicality stance as each country can offer the other a resource which it is lacking: Israel and Palestine (Gaza Strip) can offer more freshwater and Jordan can offer large quantities of renewable energy.

Israel outweighs Jordan in development potential for large-scale seawater desalination. Jordan has very limited coastline, limiting the number of feasible locations for large-scale seawater desalination plants. Furthermore, Jordan's coastline, located near Aqaba in the south, is far away from the major population and productions centers. A desalination plant near Aqaba would require an extensive network of pipelines and pumps to transport desalinated water 350km to the north and over 1,000m vertically to Amman, a system that would be technically complex and would consume a large supply of energy (Mohsen, 2007). Conversely, Israel and Gaza have a much larger coastline—and therefore more areas to develop large-scale production—close to their population centers.

Furthermore, although improvements in membrane technology have improved the efficiency, and therefore lowered the cost, of desalination, it is still an expensive process. In Jordan, the estimated cost of seawater desalination is between $1.00 and $1.70 per cubic meter, depending on the technology used and the scale of production (Mohsen, 2007). Israel, however, has found a way around these high costs: produced water from the desalination plants connects directly into the National Water Carrier (Israel's national freshwater distribution network) with the cost of desalination spread equally among all consumers. In Israel, the average cost of production is $0.66 per cubic meter, making large-scale desalination much more economically feasible (Bar-Eli, 2014). Depending on any future terms of cooperation, desalination plants in Gaza could connect to the Israeli water grid, which is already connected to much of the Palestinian water grid of the West Bank. In short, lacking the conclusions of a more detailed feasibility study, it appears to make more economic and strategic sense for Israel and Palestine (in the Gaza Strip) to produce the bulk of desalinated water as a means to alleviate the region's longer-term water needs.

[9] Israel and Jordan have each undertaken a commitment to widen their energy portfolios in the next decade, setting targets to produce 10% of their electricity from renewable sources by 2020 (Energy Charter, 2010; *Ministry of National Infrastructures,* 2010). The Palestinian Energy Agency has also set a renewable energy target for 2020: to meet 5% of its total energy demand from renewable sources (*ENPI*, 2013: 30).

With regard to renewable energy capacity, although many parts of the Negev and the Arava Valley in Israel offer suitable areas for solar power energy—and, indeed, several smaller-scale projects have been initiated in recent years (for example, the Arava Power Company)—its development potential is limited by an insufficiency of available land: almost all open spaces are either designated as natural reserves or military training areas (Oren, 2012). Palestine may have some wind power potential in the more mountainous areas of the West Bank, but solar energy capacity is extremely limited both in the West Bank and in overcrowded Gaza.

In contrast, Jordan has much more land available for large scale solar and wind energy production. A potential solar energy powerhouse, Jordan has an average of over 300 sunny days a year, with an average solar radiation of 5-7kWh/m^2, among the highest values in the world (Etier, Al Tarabsheh and Ababneh, 2010; Hartoqa, 2007). Jordan is also well equipped for wind energy generation, with wind speeds above 7m/s throughout the northern and western regions, which have the potential to generate 250W/m^2 (*Dead Sea and Arava*, 2011; Hartoqa, 2007). Currently, renewable energy provides less than 1% of Jordan's total energy supply; projects are still small and mostly experimental (Al Sou'bi, 2010; Energy Charter, 2010). However, Jordan has committed to expand its renewable energy potential, aiming to supply 10% of its electricity needs in 2020 from renewable sources, primarily wind and solar. At the present time, expected capacity is 200MW for solar production and 600MW for wind energy production (Energy Charter, 2010). As desalination is a hugely energy-intensive endeavor, renewable energy powered desalination would require large infrastructure development, which Jordan is better able to accommodate.

5. Benefits of Proposed Strategy

5.1. Potential benefits of cooperation: regional strategic stability

In addition to meeting the water demand of the three countries, the proposed method of interdependent cooperation can help foster a strategic stability in the region for four reasons. First, such a project would require long-term cooperation, not merely during construction, but also for the continued operation and maintenance of infrastructure, all of which would require close cooperation. Long-term cooperative solutions create a platform for ongoing dialogue that "fosters the building of trust between adverse societies" and can contribute to the formation of larger state-to-state interactions (Harari, 2008: 9).

Second, the project proposes levels of interdependency—not a system of shared benefits—so that no country is in the position of having the upper hand. The electricity produced in Jordan would be sufficient to produce enough desalinated water to meet Israeli, Jordanian, and Palestinian water needs. If Jordan restricted the supply of electricity to Israel, Israel could restrict Jordan's supply of water; if Israel restricted Jordan's supply of water, Jordan could restrict Israel's supply of electricity. If Israel restricted electricity supply to Gaza, Jordan could restrict electricity supply to Israel. Therefore, it would be in no parties' interest to break an agreement as all could suffer losses; the continued structure of interdependence would help guarantee adherence to such an agreement.

Third, resources often play a key strategic role as an issue that needs to be resolved before a conflict can end (Dabelko, 2006). Further increasing the production of produced water, particularly in such a trilateral manner, could encourage Israel to move forward on a final water agreement with Palestine that would replace the 1995 Israeli-Palestinian Interim Agreement (Oslo II).(Water issues have yet to be resolved between Israel and Palestine, as water is being held hostage the current political reality, namely the failure to advance the broader Israeli-Palestinian peace process (Brooks and Trottier, 2010)). Therefore, in addition to creating a project that could lead to longer-term Israeli-Jordanian stability, this agreement could help bring stability to Israeli-Palestinian tensions.

Fourth, joint management of resources can help broker broader peace agreements (Dabelko, 2006). Albeit unconventional, this project proposes joint management of water resources both directly through desalination production and indirectly through electricity supply for desalination. This mimics the ECSC's foundation, promoting regional interdependence of shared resources. As the ECSC did for broadening regional cooperation efforts in Europe, perhaps a water and energy trade can do in the Levant region.

5.2 Consequences of unilateral action

Regardless of whether a transboundary agreement is made, Jordan, Palestine, and Israel will still need to meet their growing water demands. An international agreement taking advantage of what each country has to offer is certainly the most ecologically sustainable and, perhaps, the more economical choice, as well.[10] If, however, such an agreement were not to be reached, less sustainable projects would be implemented.

In Israel, expanding desalination capacity would likely increase the number of fossil-fuel power plants. Israel's goal is to produce 600MCM of desalinated water from seawater by 2030 (Zeida, 2014). However, in 2014, Israel committed to desalinate only 360MCM of seawater (Bar-Eli, 2014). In order to meet the projection for 2030, Israel will have to increase its electricity capacity in the next few years either by building new plants or expanding existing ones.

In Palestine, over-pumping of the Coastal Aquifer is contributing to declining water quality and quantity in the aquifer ("Gaza in 2020," 2012; United Nations Economic and Social Commission for Western Asia & Bundesanstalt für Geowissenschaften und Rohstoffe, 2013). Without supplementing the current water supply available to Palestine, this practice will likely continue, to the detriment of this resource. However, water and energy interdependence could give the international community more confidence to move forward on building the proposed Gaza desalination plant, urgently required to counter the collapse of the Gaza Coastal Aquifer.

[10] The proposed project would build off existing infrastructure (such as the connection between the Sea of Galilee and the King Abdullah Canal) and would mean that each country would not have to develop and invest in the same technology.

In Jordan, there are government plans to develop nuclear energy in order to power future desalination projects, despite major objections from civil society organizations (Aburawa, 2012; "Jordan to Build Nuclear," 2013). Jordan's National Energy Strategy sets a target of producing 20% of the country's electricity from nuclear power by 2020, and the government has already planned for the construction of two nuclear power plants (Harquota, 2007; "Nuclear Power in Jordan," 2014). In addition to raising a plethora of environmental concerns, investment in nuclear energy seems counterintuitive: nuclear energy is one of the most water consumptive energy technologies, withdrawing and consuming "more water per unit of electricity produced than coal plants using similar cooling technologies"[11] ("How it Works," 2013). Ironically, the energy produced by these facilities will be used to desalinate water.

Environmentally destructive and economically unsustainable solutions, such as the Red Sea-Dead Sea Canal are also still on the table. The plan for the Red-Dead Canal is to desalinate water from the Red Sea for the shared benefit of Israel, Jordan, and Palestine. A pipeline would pump water from the Red Sea near Aqaba approximately 200km north to the southern coast of the Dead Sea, where the brine would be dumped into the Dead Sea to help stabilize the water level. While the project does promote regional cooperation, it is a much less sustainable solution. The project is hugely energy intensive: before reaching the Dead Sea, the water must travel extensive vertical and horizontal distances, requiring a significant input of energy. In addition, as most of the desalinated water is intended for Amman, additional pipelines and pumping stations would be needed to pump the water approximately one kilometer above sea level (or close to one and a half kilometers if a desalination plant is constructed at the Dead Sea) (Mohsen, 2007; Sharp, 2008). Furthermore, in addition to potential ecological threats (like destruction of Red Sea coral reefs and contamination of groundwater supplies from pipe leaks), there is concern that the brine from Red Sea water will change the chemical composition of the Dead Sea, which could cause significant damage to both the tourist and potash industries (Salem, 2009). Therefore, even though the project is intended to help alleviate the region's growing water concerns in a manner that promotes interdependence, it comes at a potentially high ecologic and economic cost.

6. Challenges to Success

As with any large-scale, international project, the challenges to successful implementation and cooperation are, unfortunately, significant in number and in scope. While promoting regional interdependence is admirable, the following challenges must be considered in assessing the feasibility of implementing such a project.

Economic Interdependence Trade Theory: Economic trade theory states that maintaining peaceful relations is in part dependent on how states view the future reliability of

[11] One reason for this is that nuclear plants do not lose heat via smokestacks, so rely more heavily on water for cooling ("How it Works," 2013).

trade. If both states expect favorable trade to continue in the future, then interdependence can foster peace (Copeland, 1996). However, if one state fears that favorable trade may not be continued, that state may resort to violence in order either to prevent that loss or to gain control of the resource to ensure continued access (Copeland, 1996; Hirschman, 1980 and Gilpin, 1997 [as cited in Oneal, Russett and Berbaum, 2003]). However, past cooperative efforts would suggest that, at least in the case of Israel and Jordan, there is an established level of trust for each to maintain an agreement. In the Jordan-Israel Peace Treaty of 1994, the two countries agreed to cooperate over water resources. In addition to allocating resources, the treaty appropriates that Israel stores water in the Sea of Galilee on Jordan's behalf, which is released to Jordan over the course of the year. Furthermore, Kilchevsky, Cason, and Wandschneider (2007) have empirically demonstrated that economically interdependent countries in the Middle East are more peaceful toward one another. Therefore, the proposed water-renewable energy community could help build peaceful relations among the three countries.

Large-Scale Infrastructure in a Conflict Zone: Water-related infrastructure is regularly targeted in warfare (Gleick, 1993). This tactic is used as a way to damage or even cripple one's enemy in a significant manner: flooding large areas that are densely populated, reducing the availability of much-needed irrigation water, or cutting off access to drinking supplies. In the 1991 Persian Gulf War, for example, both sides targeted dams, desalination plants, and water-conveyance systems for destruction (Gleick, 1993). Given regional tensions, the construction of large-scale transboundary infrastructure is risky. The implementation of this project might include the construction of high-voltage power lines to transfer the electricity from Jordan to desalination plants along the Mediterranean coasts of Israel and Gaza. While the power lines are themselves not water infrastructure per se, they would be an essential component of the larger system, making them a potential target. Heavy surveillance would be needed to ensure the security of the electricity supply; however, given the distance these power lines would cover, it would be very difficult to feasibly ensure the protection of all areas. For example, the Kirkuk-Ceyhan pipeline brings oil from Iraq to Turkey, but due to regional tensions, the pipeline is often attacked, resulting in frequent operation disruptions (*EIA* "Turkey," 2014).

Technological Feasibility: The use of renewable energy technology as a power supply for large-scale desalination presents several problems. Despite large potential for both solar and wind power in Jordan, neither is a constant, steady supply of energy: wind power depends on the velocity of the wind and solar power plants can only produce energy during daylight hours, and even then with varying intensities of output depending on the angle of the sun. Few desalination technologies allow their operation capacity to underperform, therefore precautions would need to be taken to ensure a reliable supply of energy (*World Bank*, 2012). This could include a supplementary conventional power plant (relying on natural gas) or storing excess electricity for later use (although storage technologies, such as hydroelectric "pumped storage," which are already implemented in a few places in Israel, have limited capacity and are still largely experimental) (Dolev et al., 2013). In addition, regarding solar energy, different challenges arise depending on the technology used. The use of photovoltaic panels, especially in a desert setting, would require regular cleaning as layers of dust and sand reduce the efficiency of the panels (Sulaiman et al., 2011). Another option is concentrated photovoltaics (CPV), which is gaining market traction in the Middle East, but is not yet economically competitive with conventional photovoltaics ("IHS," 2014). However, a study conducted by the World Bank assessing the feasibility of renewable energy desalination in the Middle East-North Africa region asserts that only large arrays of concentrated solar power (CSP) technologies have the "potential to economically produce thermal and electrical power sufficient to produce [enough] desalinated water…[to] supply towns and cities" (*World Bank*, 2012: 88). However, CSP technologies require water for cooling and steam generation, which could be a limiting factor, particularly in a desert environment (*World Bank*, 2012).

Load Sharing and Interconnected Electricity Grids: Israel, Jordan, and Palestine have each independently set goals of expanding their renewable energy capacity in the coming years. While this demonstrates a vested interest in more sustainable energy supplies, the intention of these policies are for meeting the projected electricity demand as it currently stands and for becoming more energy independent. Therefore, any project proposing the large-scale development of renewable energy technologies would have to take into consideration load sharing, determining what portion, if any, of the electricity generated would go to meeting domestic demand in Jordan, Palestine, and Israel and would have to account for fluctuations in demand. Further complications arise as a result of the Arab Electricity Grids Interconnection Project (also referred to as the Eight Country Interconnection Project). Starting as a five-country agreement in 1988, this initiative now connects the electricity grids of eight countries: Egypt, Iraq, Jordan, Libya, Lebanon, Palestine, Syria, and Turkey—strategically avoiding the incorporation of Israel ("Electricity," 2012; *World Bank*, 2013: 273). This neglect would suggest that these countries do not want Israel to connect to a pan-Arab grid, which would make connecting Israel to Jordan's electricity grid a significant political challenge.

Comparative Economic and Political Desirability: Israel has begun to develop three large reserves of fossil fuel (two natural gas fields and an oil shale reserve, which is expected to be brought online in 2024) (Fink, 2013; Silverstein, 2013; Zomer, 2013). Using these resources, Israel could meet its domestic energy and electricity demand for at least the next few decades (although Israel Energy Initiatives (IEI), the Israeli company developing the oil shale, maintains that there is enough kerogen in the oil shale to guarantee Israeli energy independence for the foreseeable future (Grumberg, 2011)). However, concerns over environmental degradation might prevent the oil shale project from seeing the light of day (Rinat, 2014; Udasin, 2014a). Furthermore, many of Israel's desalination plants have (natural gas) power plants located nearby as a power source, which is comparatively less expensive (it requires less infrastructure and fossil fuels are currently a much cheaper fuel source than solar energy) and less risky (it is easier to protect a centralized power plant than an electric grid expanding several hundred kilometers) than the proposed project.

Political Will: A project requiring regional interdependence is always a political challenge, as it requires countries to give up partial sovereignty and control over their security. However, there is a history of cooperation over water resources that suggests that future cooperation over water is possible. Under Article 6 of the Jordan-Israel Peace Treaty both countries recognize the need to increase their water supplies and agree to do so though projects that include regional and international cooperation. In addition, as detailed earlier, in December 2013 the governments of Israel, Jordan, and Palestine signed a Memorandum of Understanding over a desalinated water exchange.

7. Conclusion

With growing demand and dwindling supplies, the need for freshwater resources in the Levant has never been greater. With pressures mounting, new and creative solutions are needed to solve this regional water crisis. Resource trading between countries rich in unconventional resources can offer a solution to this problem: Israel, with proven large desalination capacity, Palestine, with desalination potential, and Jordan, with large renewable energy potential, can cooperate and share their resources in order to generate enough water to meet all of their collective water needs.

Although there are ongoing projects—some unilateral and some jointly cooperative—seeking to increase the supply of water, a system that promotes interdependence—such as the one proposed—is more likely to be sustainable in the long run. An agreement fostering mutual dependence would help level the playing field making Israel, Palestine, and Jordan better partners in an agreement, relying on interdependence to meet their needs.

No less important from a geopolitical perspective, in addition to meeting their water needs, a project seeking to rectify environmental grievances can help foster larger regional cooperation and stability. Continued water scarcity can be a source of political instability that threatens the very viability of a national government; therefore, solving the relatively low-hanging fruit of water shortages can help alleviate some of the regional tensions. Furthermore, the necessary long-term cooperation for implementing such a project can help foster dialogue over more politically challenging issues and can act as a stepping stone toward the creation of other regional cooperative bodies, perhaps even leading to larger regional unification. Although this proposed interdependence effort is not without significant challenges, it could be a much needed first step toward greater regional cooperation and stability.

Future research is needed to assess the technical, economic, and political feasibility of such a proposal. Future research should examine the following issues:

1. The technical feasibility and possible options for large-scale desalination powered by renewable energy (primarily solar).
2. The economic feasibility of implementing different solar options and economically feasible alternatives.
3. Assessing the political will for engaging in such a project.
4. The technical and political feasibility of connecting Israel and Palestine to Jordan's electricity grid.
5. Methods to protect infrastructure, especially during times of heightened conflict.
6. Estimating cost of development and evaluating sources of funding.

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