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Virtual Allocations: 
*Expanding the Framework of Hydro-Hegemony*

to Inform Virtual Water Trade

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Abstract

This paper investigates the relationship between access to water resources, global trade patterns, and power through the lens of virtual water and hydro-hegemony. “Virtual water” has been defined by Tony Allan as “the water needed to produce agricultural commodities”, with recognition that the term could be expanded to include other commodities as well (2003). Virtual water trade refers to the ability of countries to trade ‘water’ by importing and exporting goods requiring water for production, rather than actual water.

Proponents of virtual water trade argue that food trades from water-rich, arable land to arid land can help to enhance the arid area’s food and water securities, freeing up local water resources for other uses. Critics of the virtual water discourse are concerned that highlighting markets and trade as the saviours of water-poor countries may be yet another component of the neoliberal economic prescription. This paper will seek to shed light on this debate, considering the power relations at play in how virtual water is accessed and allocated by expanding the Framework of Hydro-Hegemony.

In 2006, Zeitoun and Warner introduced the Framework of Hydro-Hegemony, an analytical tool for analysing transboundary water conflicts. This paper will expand that Framework to be relevant for analysis of virtual water trade patterns. Applying this expanded Framework of Virtual Hydro-Hegemony to three case studies (Peruvian asparagus exported to the United Kingdom, American cereals imported by Egypt, and Israeli agricultural produce consumed in the European Union) indicates that virtual water flows are highly subject to hydro-hegemony, shaped by material, bargaining, and ideational powers. The paper will conclude with suggestions for how scholars and practitioners concerned with access to resources might engage with virtual water allocations.
Peru sues UK

*President Ollanta Humala of Peru has accused the United Kingdom – along with the Netherlands and the United States – of “eating our water” in breach of international water, trade, and human rights law*

The three commercial powers have been the top importers of Peruvian agricultural produce, especially asparagus, for over a decade. Now, Peru seeks reparation for what it sees as “pressured trade relations”. The Peruvian government is pursuing a three-pronged legal approach.

**International water law**

The 1997 Convention on the Law of Non-Navigational Uses of International Watercourses holds that transboundary water resources should be shared according to “equitable and reasonable use”, further stating that states should “do no harm” in their use of shared resources. Peruvian lawyers are seeking to argue that the 1997 Watercourses Convention should apply not only to surface and groundwater supplies that directly cross borders, but also the “virtual water” that crosses borders through trade.

“Virtual water” refers to the water embodied in goods through their processing. It is most often used in reference to agricultural produce. The water used for irrigation, the water present in the soil, and the water necessary for packaging and transport can all be considered part of the product itself.

In order to grow asparagus for export year-round, Peruvian corporations unsustainably exploit local aquifers for irrigation. Local smallholder farmers and indigenous communities have found traditional water sources dried up. The Peruvian government holds that the price for this water has not been accounted for in export prices, and that consumers in the Netherlands, UK, and US are essentially “eating” Peru’s water without paying for it. The government argues that such use is not equitable or reasonable, also violating the “do no harm” regulation of the Watercourses Convention.

*Image credit Nick Hepworth, Water Witness International*
International trade law

Members of the World Trade Organisation are bound by the General Agreement on Tariffs and Trade (GATT), which states that countries must treat all other member states equivalently in terms of trade relationships, with a few exceptions.

One of those exceptions covers environmental protection. Article XX allows for trade restrictions when they are “necessary to protect human, animal or plant life or health” or relate “to the conservation of exhaustible natural resources”. The Peruvian government seeks to demonstrate that asparagus production exhausts local aquifers, at great harm to human, animal, and plant life in the region. As such, they argue that trade restrictions are necessary and allowable.

International human rights law

In addition to state-based water and trade law, the Peruvian government is appealing to human rights law to aid its case. The United Nations declared water a human right in 2010. Peru is arguing that consumers in the Netherlands, UK, and US – already surrounded by ample water resources – are infringing upon Peruvians’ right to water by purchasing asparagus at prices that do not adequately redress the water loss.

The above news story is entirely fictional. It is also essentially impossible.

The 1997 Watercourses Convention was not intended to apply to virtual water flows. Since international law relies on voluntary state compliance, this agreement could not be used to punish a state, even if the logic is parallel and sound. Exceptions in the GATT are meant to allow for import restrictions from specific countries, not exports: Countries are not required to export anything. While the human right to water is recognised, very little is in place to guarantee the actualisation of this or any other right. It is incredibly unlikely that importing countries and consumers would be held responsible for agricultural practices taking place within Peru; indeed, it is more likely in today’s legal regime that Peru would be able to challenge a UK decision to stop importing Peruvian asparagus than that Peru realistically could seek recompense from the UK for doing so.

But the reality is that Peruvian asparagus production is draining aquifers, and locals in the arid mountains where asparagus is grown are feeling water stress, and the already water-
rich residents of the UK are gaining access to asparagus year-round (Lawrence, 2010). And there are very few options open to local Peruvians for combatting this.

What would it take to make the above news story a reality? This paper seeks to explore access to and allocation of virtual water, focusing on the law and power issues innate in virtual water trade. Its primary research questions are:

1. How are certain forms and understandings of water prioritised in scholarship and policy?
2. How does this prioritisation impact virtual water trade realities and access to water resources?
3. How does power and hydro-hegemony influence virtual water allocations?
4. Might international law be utilised to redress misplaced water priorities and trade injustices? What would such counter-hegemonic action look like?

Considering these questions using the Earth Systems Governance framework, this paper demonstrates that global food, water, and economic systems are inextricably bound together through virtual water allocations. The four primary research questions will be examined through an expansion of the Framework of Hydro-Hegemony first introduced by Zeitoun and Warner in 2006. By applying the Framework of Hydro-Hegemony not only to transboundary water conflicts, but also to virtual water trade and water scholarship itself, this paper will argue that:

1. Our knowledge of blue water (readily accessible freshwater) has a “conceptual hydro-hegemony” over other forms of water, including green water (soil moisture) and virtual water;
2. Virtual water allocations are highly subject to hydro-hegemonic systems of power; and
3. The norms created by and codified in international law could go a long way in combatting the inequalities arising from Conclusion #2 but are themselves currently subject to Conclusion #1.

After situating itself in the Earth Systems Governance literature, this paper will discuss how literature was identified, case studies selected, and data accessed and analysed in its Methodology and Framework section. Expanding the Framework of Hydro-Hegemony will introduce the original Framework and discuss how it has since been used and revised in scholarship. Two major theoretical extensions of the Framework will then
be presented: the conceptual hegemony certain forms of water can attain in water scholarship and policy (e.g., blue water over green water) and the hegemony present in virtual water trade relations. The Role of International Law will consider the origins of international law and the areas of law most relevant to hydro-hegemony and virtual water flows, most notably international trade law, international water law, and international human rights law. Three case studies will be presented: Peruvian Asparagus in the UK, US Cereals in Egypt, and Israeli Agriculture in the European Union. Each case study will identify current virtual water trade patterns, determine which laws are relevant, and analyse hydro-hegemonic practices in the trade relationship. Conclusions will discuss patterns found in the case study evaluations; examine the relationship between virtual water trade, extent law, and hegemonies; and suggest future directions for action and research.
Methodology and Framework

This paper is grounded in the Earth Systems Governance (ESG) framework, testing an expansion of the Analytical Framework of Hydro-Hegemony to examine some of the ESG’s core interest areas. Three case studies serve to test and demonstrate the theoretical framework. This Methodology and Framework section will summarise the ESG framework, consider ethical concerns and research positionality, present the techniques used in identifying reviewed literature, and discuss how case studies were selected and analysed.

The Earth Systems Governance Framework

The Earth Systems Governance Framework explores the relations between rules, systems, and actors that influence environmental change and development (Biermann, 2007). The ESG community is interested in ‘governance’ widely defined, considering not only official and traditional policy-making realms but also more decentralised arrangements at various scales and incorporating a multiplicity of actors.

This paper considers the analytical problem of Allocation and Access within the ESG, focusing on virtual water flows through food trade. Each of the four themes of the ESG project (power, knowledge, norms, and scale) are highly relevant to virtual water allocations. This paper will consider the ways that access to virtual water is strongly tied to forms of power through its expansion of the Framework of Hydro-Hegemony to analyse virtual water allocations; demonstrate that knowledge of virtual water is still lacking by all actors at all scales; and show that the allocations of virtual water resources are shaped by social norms. It will argue that knowledge of virtual water allocations and the creative use of norms, particularly through international law, can help us to better address unequal access to water and food resources both locally and globally.

Literature and Law Review

International law and virtual water are both trans- and interdisciplinary subjects; their intersection means that scholarship from nearly every academic discipline is relevant to this paper. Hydrology, politics, agricultural sciences, economics, engineering, law, the list goes on. Rather than searching discipline-specific journals, then, interdisciplinary catalogues such as EBSCOHost, JSTOR, Project Muse, and ProQuest were searched with key terms including “virtual water AND law”, “water trade AND power”, and “virtual water AND hegemony”. Articles citing Zeitoun and Warner’s initial publication on the
Framework of Hydro-Hegemony were sought to see how the framework has been applied and reviewed.

Extant international law and legal disputes on water, trade, and human rights is also applicable, the actual language of these laws and disputes served as a key source of both primary data and background information for this theoretical expansion and application. The texts of laws and disputes were accessed via the United Nations public websites.

These collected articles, laws, and disputes informed a theoretical reworking of the Framework of Hydro-Hegemony, revised to be applicable to water scholarship itself and to virtual water flows.

Case Study Selection
The ethical implications of theoretical research come primarily from case study selection, data sources, and its potential uses. Case studies draw attention to certain issues and groups of people, this attention can be good or bad, as it may bring money or further research meant to address problems but may also create unintended or undesirable consequences. The corollary is that selecting some case studies mean others are not selected; this may detract attention from issues or places that need it. Because this paper seeks to present how a revised theoretical Framework of Hydro-Hegemony can shed new light on virtual water trade, case studies were deliberately chosen that have previously had scholarly or media consideration. The author hopes that readers will have had some exposure to these case studies and thus find a personal connection to the theory’s potential applications.

Three case studies were chosen to demonstrate the application of the Framework of Hydro-Hegemony on virtual water trade and international law’s impact on that trade. The three cases are:

1. Asparagus exported from the Republic of Peru to the United Kingdom,
2. Cereals exported from the United States to Arab Republic of Egypt, and
3. Agricultural produce exported from the State of Israel to the European Union.
Of course, three case studies are hardly able to speak for the entirety of virtual water trade relations. The use of these case studies should be seen not as an attempt to speak definitively about the nature of virtual water trade and law, but rather as an argument for the importance of considering power and politics in these relations and the value of a revised Framework of Hydro-Hegemony in doing so.

Hydro-hegemony raises numerous complex and nuanced geopolitical power issues. These particular case studies were selected in order to provide insight into a variety of virtual water trade systems. Each of the case studies speaks to vastly different hydrological, economic, and political realities; all are characterised by strong imbalances of power, albeit in various ways. The three case studies consider virtual water flows from rich to poor countries and poor to rich, from wet to dry countries and dry to wet, from more technically advanced to less technologically advanced countries and less to more, from politically stronger to politically weaker countries and weaker to stronger.

The use of Israel in one of the case studies is immediately and strongly political. To some, scholarship incorporating Israel is seen as normalising the country. A lengthy tangent on this issue would be out of place, but the issue is a real one and needs to be acknowledged. Some of the power and ethical issues at play in Israel’s case are considered in the evaluation of its hydro-hegemonic position, as they are for each case study. However, it is important to recognise that fully evaluating each country’s background and position is impossible. This does not diminish the value of real world case studies or undermine the power of this paper’s conclusions, but the limitations should be named and accepted, in this and all scholarship.

**Data and Analysis**

For each case study, an examination of the defined virtual water flows and relevant international law was completed. The Virtual Hydro-Hegemony (VHH) of each trade relation was plotted. Appendix A provides detailed information on the criteria, proxy indicators, and methods used in VHH plotting. Trade realities and germane laws were considered in the light of these hegemonic positions. The three case studies were compared to identify patterns in virtual water hegemony and law.
The bulk of this paper’s empirical evidence comes from economic and geographic data collected from The World Bank, the CIA World Factbook, and the Water Footprint Network. The particular statistics and data sources chosen were selected based on availability and consistency across countries. No meaning or weight should be given to their selection beyond that, though using this data could be seen as a legitimation of the organisations or methodologies. Figures such as the GDP and estimated population, flawed as they are, serve as proxies for countries’ sizes, needs, and powers. Water footprinting is heavily critiqued but serves to quantifiably estimate virtual water flows (Berger and Finkbeiner, 2010, Lillywhite et al., 2010, Vanham and Bidoglio, 2013). They are not perfect measures, but none are. After all, “…essentially all models are wrong, but some are useful…” (Box, 1987: 424).

**Researcher Positionality**

The author is a white American currently living in the United Kingdom. She has spent time in Egypt and Israel; Peru is the only economy under consideration she has no personal connection with. The author is trained in anthropology and international relations, and is interested in the intersection between micro and macro levels of analysis. Her primary interest is in food security; this bias is seen as each of the case studies deals primarily with agricultural issues even as she critiques the virtual water and water footprint literatures for being food-centric.

This paper seeks to ask and answer counter-hegemonic questions, and the data presented and discussed are meant to question and challenge the status quo. And while scholarship and information can always be misinterpreted to support inequalities, this author hopes that it will be read and utilised in the same light.
Expanding the Framework of Hydro-Hegemony

In 2006, Zeitoun and Warner published an article in *Water Policy* introducing “Hydro-hegemony – a framework for analysis of trans-boundary water conflicts”. The Framework of Hydro-Hegemony (FHH, or simply “the Framework”) was designed to better inform “who gets how much of the water, how and why” in trans-boundary water conflicts by bringing multiple forms of power into the debate while understanding the various intensities and forms of conflict (Zeitoun and Warner, 2006: 436).

Hydro-hegemony is defined by Zeitoun and Warner as “hegemony at the river basin level, achieved through water resource control strategies such as resource capture, integration and containment” (2006: 435).

Hegemons make use of various kinds of power to maintain their positions and advance their interests. In 1974, Lukes suggested a three-tiered typology of power, Zeitoun and Warner, along with many other political and social scientists, adapt this typology to inform their Framework. The most obvious form is material power. This first dimension includes economic and military power as well as technological capacity. The second dimension, bargaining power, revolves around the ability to control the “rules of the game” (Zeitoun and Warner, 2006: 442), influencing the agenda, what is and is not on the negotiating table, etc. Appeals to international law are a component of this second dimension of power. So, too, is the ability to create, write, and veto international law. The third dimension of power is the most difficult to concretely grasp, and also probably the most difficult to counteract. Through ideational power, hegemons influence ideas and assumptions – not merely their own, but also other actors’. The third dimension is the capacity to create, uphold, and destroy narratives, perceptions, and knowledge. These last two dimensions of power – bargaining and ideational – are sometimes referred to as “soft power”, a term coined by Joseph Nye in 1990 and expanded upon in 2004. In contrast, the first dimension is often called “hard power”.

State actors are frequently engaged with each other in conflicts over water and other natural resources, but these conflicts do not always take the form of armed warfare. Yoffe et al. created a scale for analysing the intensity of water-based conflicts (2001), Zeitoun and Mirumachi (2008) and Zeitoun, Mirumachi, and Warner (2010) demonstrate how certain forms conflict and cooperation may coexist in transboundary water interactions.
The absence of military action – and even the presence of cooperation – does not mean that conflict and/or hegemonic control over water resources is not taking place.

Nor are conflict and hegemony automatically negative. Certain forms of hydro-hegemony may result in positive leadership creating shared control over water resources. The presence of conflict may alert a hydro-hegemon to extant inequalities. Zeitoun and Warner’s Framework of Hydro-Hegemony creates a structure for analysing how control over water resources is gained, maintained, and could be changed. **Figure 1** shows the three pillars Zeitoun and Warner posit as forming hydro-hegemony. In this first presentation of hydro-hegemony, the three dimensions of power are combined as one pillar, with riparian position (location upstream or downstream) and exploitation potential (technical infrastructure and capacity for gathering and storing water) as the other two. Revisiting the Framework in 2010, Cascão and Zeitoun suggest making each of the three dimensions of power its own pillar, with “Geography” as the fourth. The original pillar of “Riparian Position” is part of “Geography”; the infrastructure forming “Exploitation Potential” is part of “Material Power” (2010). Cascão and Zeitoun use **Figure 2** as a way to easily demonstrate which is the hegemon in a transboundary context: The four pillars are plotted for each of the riparians, with longer pillars signifying greater control. Comparing the plots allows for a visual understanding of which riparian is the hydro-hegemon. See **Figure 3** for an example.

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**Figure 1.** The Original Pillars of Hydro-Hegemony.

**Figure 2.** The Revised Pillars of Hydro-Hegemony.
From Cascão and Zeitoun, 2010: 32.
Figure 3. Plot of the Hydro-Hegemonic Configuration in the Eastern Nile River Basin. From Cascão and Zeitoun, 2010: 33.

Cascão and Zeitoun’s revision allows for a more nuanced analysis of power, which Zeitoun and Warner’s original study argues is the “prime determinant” in many water conflicts (2010: 451). However, it does not expand all that much on the original Framework. The Framework of Hydro-Hegemony is very state-centric, essentially ignoring non-state actors as well as national and transnational contexts. Multiple scholars point to cases in which these other levels are necessary to understand transboundary water conflicts (Farnum, 2013, Lopes, 2012, Warner and Zawahri, 2012).

But even adding a consideration of multi-scalar actors does not take the Framework of Hydro-Hegemony as far as it could go. The principles of FHH can be used to consider not only transnational river basins, as they have generally been thus far, but also any situation in which power and politics influences understandings of, access to, and the distribution of water-based resources. Given the all-pervasive nature of power and politics, revised Frameworks of Hydro-Hegemony can be used to inform virtually all water scholarship. This paper will focus on two of these possibilities: that of water knowledge itself (Conceptual Hydro-Hegemony) and that of hegemony in virtual water trade (Virtual Hydro-Hegemony).

**Conceptual Hydro-Hegemony**

“Writing on hegemony and on water conflict analysis in general tends to be the political science of the winners” (Zeitoun and Warner, 2006: 438). Water scholarship and policy are subject to the same power biases and hegemonies as water resources themselves. Dominant understandings of water can be “conceptual hydro-hegemons”. These hegemonic policy and research agendas and assumptions inform how water is seen, analysed, and used. The classic hydro cycle illustrating water movements almost exclusively in terms of biophysical processes, the fourth Dublin Principle asserting water
as an economic good, and the prevalence of Integrated Water Resources Management (IWRM) as a policy frame are examples of conceptual hydro-hegemons. Mainstream water scholarship, policy, and teaching prioritises surface water over groundwater, blue water over soil moisture, direct water trade over virtual water flows, etc.

These conceptual hydro-hegemonies are the result of historical emphasis in research and policy. This emphasis may be the result of less advanced hydrologic knowledge of water, lesser obviousness, and/or vested political interests. Once a particular understanding of water takes hold, it is difficult to change. Alternative approaches to water knowledge and science will have a hard time gaining mainstream acceptance as they become counter-hegemonic. Conceptual hydro-hegemony comes primarily from ideational power, perhaps the most difficult dimension to identify, track, or counter. Even scholars who wish to tackle hegemonic ideas in water may be limited by those very ideas, constrained by the paradigms that define what water is and isn’t.

This can be clearly seen, ironically, in the original Framework of Hydro-Hegemony itself, which focuses on blue water conflict in shared river basins. But an expanded Framework with these conceptual hydro-hegemonies in mind can be utilised to help inform counter-hegemonic action and discourse.

**Virtual Hydro-Hegemony**

“Virtual water” has been defined by Tony Allan as “the water needed to produce agricultural commodities,” with recognition that the term could be expanded to include other commodities as well (2003). Virtual water (VW) trade refers to the ability of countries to trade “water” by importing and exporting goods requiring water for production, rather than actual water. Water used in production may be “green” (soil moisture), “blue” (surface and ground water), or “grey” (water required to dilute pollutants). Crop and livestock imports and exports account for the majority of global virtual water trade (Hoekstra and Chapagain, 2008), as most of the world’s water is found in the soil and is not directly accessible by humans.

Proponents of virtual water trade argue that food trades from water-rich, arable land to arid land can help to enhance the arid area’s food and water securities, freeing up local water resources for other uses. Other authors point out that “Food trade is a
socioeconomically and politically very complex issue, particularly in poor countries depending on agrarian economies, rendering its role in supporting hunger and poverty alleviation uncertain” (Rockström et al, 2007: 6258), and argue that “Not all forms of virtual water are equal” (Biro, 2012: 97). Critiques of virtual water discourse are concerned that “extolling the virtues of markets and imports as against domestic production” are yet another component of the neoliberal economic prescription (Iyer, 2008: 16).

Tracing the patterns of food imports and exports globally raises several questions. The comparative advantage argument – that it is economically a better use of global water resources for water-rich countries to produce water-intensive crops and export them to water-poor countries – has some merit, but relying solely on this argument ignores historical and current power asymmetries. Nor do food trade patterns always follow comparative advantage and economic principles. It is seemingly irrational for the United States and Australia to export relatively unprofitable cereals – especially as Australia is the world’s driest inhabited continent yet its biggest water exporter (Biro, 2012: 97). Given how grains are subsidised in these countries, cereals are sometimes sold at less than their cost of production (ibid: 97-98). But virtual water may provide a political function: “as these food exports help assure regime stability in the Middle East, they can equally be seen as an investment in oil supply security” (ibid: 98).

Virtual water flows, then, are not free of the political and power concerns found in any other transboundary water interaction. A revised FHH can be utilised to better understand the motivations behind and potential results of VW flows. The four Pillars of Virtual Hydro-Hegemony are shown in Figure 4.

- **Domestic Endowment** refers to the water-based resources a country has available to it internally. This includes basic water quantities, but also water renewal evapotranspiration rates.

- **Material Power** includes economic,
military, and technological power. For virtual water trade, GDP and water infrastructure quality is most relevant.

- **Bargaining Power** relates to a trading partner’s ability to influence the conditions of the trade, including influence over relevant institutions like international law.

- **Ideational Power** refers to the power to shape perceptions and assumptions about virtual water trade. This might involve framing VW trade as an issue of food or state security, sharing or withholding information, etc.

The four pillars of Virtual Hydro-Hegemony can be plotted in any VW trade relation, similarly to how Cascão and Zeitoun plot the hydro-hegemony of riparians in various transboundary river basins. A suggested methodology for plotting VHH can be found in Appendix A. The next section, **The Role of International Law**, takes a closer look at how international law influences and is influenced by ideational and virtual hydro-hegemonies.
The Role of International Law

Ideally, “law is the protector of the weak” (Frederick Schiller). Too often, though, it seems that “The function of the law is not to provide justice or to preserve freedom. The function of the law is to keep those who hold power, in power” Gerry Spence (1996: 90). This is true in local and national law, but perhaps even more so in international law. International law and cooperation have come a long way since the United Nations was born in 1945, but the world system is still technically anarchic: Formally, states have complete sovereignty over their territories and there is no greater power than the nation-state. Unlike a citizen of a country, who is bound to that country’s laws whether she wishes or not, states are not answerable to a force higher than themselves. While international law exists, it is based entirely on voluntary compliance: States are bound only if they wish to be.

This does not seem to bode well for the ability of international law to control states or protect weaker states from bullying hegemons. State actors have admitted to – and demonstrated – their willingness to breach international law when it serves their interests (Baradan et al., 2013). But this does not mean that international law has no influence. Huth’s et al. study of 165 territorial disputes since 1945 found that actors who had strong legal claims are more than twice as likely to seek negotiations before using force (2011). International law shapes states’ bargaining power. It also creates and reproduces ideational power. “It is true that international law did not stop Saddam Hussein from invading Kuwait in August of 1990, but it made possible a resolution condemning that invasion the very same afternoon. International law shapes the way the many nations of the world digest an event, it shapes the way an event is discussed: which arguments are in and which are out” (Caron, 2004: 312).

International law reflects and reproduces global discourses on issues. It shapes and perpetuates norms of behaviour. As such, it is a powerful player in soft power – and thus in hydro-hegemonies – even when it does not carry with it a strong global police force with hard power (Daoudy, 2008). This section will provide an overview of the components of international law that most impact virtual water trade.
International Trade Law

International trade law (ITL) deals with the trade of goods between countries. Modern ITL is based primarily on the World Trade Organization (WTO), born on 1 January 1995 as an institution “whose primary purpose is to open trade for the benefit of all” (WTO, 2013a). Like all international law, the WTO’s rules and regulations are applicable only to member-states that have signed onto the agreements. All of the actors involved in this paper’s case studies are members, and so ITL is applicable to each of the cases.

The WTO integrates preexisting trade agreements (most notably, the General Agreement on Tariffs and Trade, or GATT, in effect 1948-1995) with new treaties to create a binding framework for trade negotiations and dispute resolution. The WTO’s primary principles are non-discrimination, transparency, competition, lower trade barriers, and environmental and societal protections. Member countries are required to treat all other member countries as “most favoured nations”: The same conditions for trade (quotas, tariffs, etc.) must be applied to all partners, and non-WTO members cannot be given better treatment. There are exceptions for regional trade agreements and the like (e.g., because of the European Union, France is permitted to treat German and Israeli imports differently). Through the national treatment policy, once foreign goods have entered the market, they must be treated the same as domestic goods (e.g., while a tariff may be applied at the border, an additional tax may not be charged to consumers at a store). WTO members agree upon tariffs, quotas, and trade deals, the Organization helps to enforce these deals and arbitrates disputes.

It is not necessarily clear whether or not “water in its natural form” is considered a “good” to be regulated by the WTO, North American Free Trade Agreement (NAFTA) purposefully does not include water in its provisions (Baillat, 2010: 97, Rand, 2012). But the goods that transport virtual water – agricultural produce and manufactured products – certainly do. As such, the WTO oversees nearly all virtual water trade between WTO members. The Organization’s work to reduce trade barriers serves to increase virtual water flows. Food safety laws, import quotas, and tariffs all influence where and how virtual water travels. The WTO is at least minimally aware of this: One of its recent working papers explores the “relation between international trade and freshwater scarcity” (Hoekstra, 2010). The paper argues that international trade reduces the global
use of water in agriculture but notes that “the WTO explicitly refrains from making environmental agreements” (ibid: 2).

The controversial Tuna-Dolphin GATT cases of the 1990s made popularly known the WTO exceptions for restricting trade on the basis on something “necessary to protect human, animal or plant life or health” or “relating to the conservation of exhaustible natural resources” (WTO, 2013b), however, the Tuna-Dolphin cases also made popularly known that the WTO will only apply these exceptions to the products themselves, not the processes or policies that produce them (World Trade Organization Panel, 1994). Virtual water is almost entirely about the process of production rather than the product itself, as such, historical cases such as the Tuna-Dolphin disputes indicate that ITL as it currently exists is incredibly unlikely to be of use in addressing VW concerns.

*International Water Law*

Several international treaties deal with water in some form, the majority of these agreements deal with navigational, transport, and territorial concerns. Leaving aside the law of the sea and similar, international water law (IWL) is still heavily blue water-centric, dealing almost exclusively with transboundary surface and groundwater resources.

The primary piece of legislation currently governing shared water resources is the 1997 United Nations Convention on the law of the Non-Navigational Uses of International Watercourses, which stipulates that “equitable and reasonable utilization” (ERU) should govern countries’ access to shared resources. Seven factors determine what ERU entails: a country’s territory within the basin, runoff contribution, population, current and expected GDP/capita, poverty measure, and current use. Countries make claims to ERU using the factors that benefit them, but counterclaims mean that the seven factors essentially balance each other out (Farnum, 2013, Lankford, 2012).

The 1997 Watercourses Convention has not been ratified by many countries. The US, the UK, Peru, Israel, Egypt, and the EU as a whole are not signatories; the Convention is thus not in force for the case studies discussed in this paper. Nonetheless, the ERU principle supports many states’ claims to shared water resources, and is an important part of ideational power in hydro-hegemony.
Like international trade law, international water law says virtually nothing explicitly on virtual water. Van der Zaag et al. argue that states need to consider the value of blue and green water relative to each other while determining ERU, but this is not generally part of the accounting (2002). While IWL’s logic and frameworks could potentially be applied to virtual water flows, this cannot be legally enforced without states’ agreement. Nor would parallel adoption of IWL principles to virtual water law (VWL) necessarily be in weaker parties’ best interest. Woodhouse and Zeitoun argue that IWL needs to incorporate hegemonic practices if ERU is to truly be operationalized (2008). This is not currently done: Burleson points out the insufficiency of current IWL in addressing waters shared between one state and one non-state or unrecognised state actor (e.g., Israel and Palestine) (2005-2006); Tarlock highlights the gap between the principle of ERU and wealthy states’ incentives to take unilateral action (2009: 371).

**International Water Policy: The Dublin Principles**

Water law and water policy are not the same thing. Formally speaking, agreed-upon law is binding while policy is not in an international setting (Cullet, 2012). But the distinction between the two is not always obvious, and policy, like law, can shape ideational power. The 1992 Dublin Statement is policy, but it is one of the most well-known and often-cited international statements on water.

The Fourth Dublin Principle states “Water has an economic value in all its competing uses and should be recognized as an economic good” (International Conference on Water and the Environment, 1992, emphasis added). While the framing of water as an economic good rather than as a human right is contested by NGOs and activists, the Dublin Principles retain a strong influence on water discourse and policy, globally and locally. The framing of water as an economic good certainly contributes to rationalising virtual water flows as a beneficial trade for countries.
International Human Rights Law

In 2010, the United Nations formally recognised the human right to water (United Nations General Assembly, 2010). This was an ideational victory for many activists and NGOs, hoping this human rights language could replace the economic rationale of the Dublin Principles. But what power does human rights law truly hold? The Universal Declaration of Human Rights (UDHR) was adopted in 1948 by the newly born United Nations but is not formally a treaty. The binding legal obligations of states to protect and fulfill human rights come primarily from successor treaties such as the International Covenant on Civil and Political Rights and the International Covenant on Economic, Social and Cultural Rights, neither of which explicitly consider the human right to water.

Again, there is a disconnect between virtual water concerns and mainstream understandings of “water”. The Resolution recognising water as a human right specifically names “drinking water and sanitation”. Other human rights are perhaps more relevant to virtual water flows: The human rights to property, employment, and health and food could be applicable. Even so, all human rights suffer from the same basic issue: “If legal tools are to benefit the world’s poor and disenfranchised, they cannot be void due to the impossibility of implementation. This is the problem with the purported human right to water: it is quixotic” (Kornfeld, 2009: 701). Rights are too often unenforceable, and the blame for their nonexistence is difficult to place. While human rights receive a great deal of criticism for this, their ideational power is still relevant to discussions of hydro-hegemony, and evolving human rights law may yet prove to be a useful tool in developing virtual water law.

Conceptual Hydro-Hegemony in Virtual Water Law

Though the above extant legal frameworks all have implications for virtual water trade, the concept of virtual water has not yet explicitly entered the realm of international law. “International water law” is little more than “transboundary river basin law” combined with historic agreements on the law of the seas for navigational and territorial purposes. There is no “International Virtual Water Trading Council” or “Treaty on Virtual Water Flows”, though the former has been suggested (McKay, 2007). Nor have many scholars yet tackled the issue of international law and virtual water. An average international trade lawyer may not even know what “virtual water” means. Article after article on global and international law has nothing to say on virtual water (Dauody, 2008, Dellapenna and

International law is clearly subject to the same conceptual hydro-hegemonies as the rest of water scholarship. But certain authors and articles are beginning to counter this hegemony. Gerlak et al. argue for paying virtual water more attention: “This concept of virtual water is especially significant for equity in water-short areas because it seeks to trace hidden or unintended movement of water” (2009, 313). Liao et al. content that the “failure to consider water resources may distort analysis of trade liberalization” (2008: 503). Litovsky and Villapando point out that virtual water exports influence land security, and laws concerning land ownership should take this into account, especially as it concerns small-scale agriculture (2012). Sindico discusses the possibility of treating water as a foodstuff, argues for the need for a dispute settlement mechanism for water transfers, and considers the wisdom of giving water a waiver in WTO reforms (2007).

In spite of these developments, scholars continue to generally focus on either agricultural or “actual” water, rarely are the two integrated. Virtual water ad international law discussions are heavily focused on agriculture and land. This is a sub-conceptual hydro-hegemony in and of itself: Agricultural-based virtual water continues to have conceptual hydro-hegemony over virtual water flows in manufacturing, energy, technology, services, etc. This is presumably the direct result of its origins: The term’s creator, Tony Allan, developed the concept with agricultural commodities in mind (Kumar and Singh, 2005: 760). But properly considering water requires considering it in all its forms, including all its virtual forms.

Lastly, careful reading of literature shows that VW concerns are often considered without the term “virtual water” explicitly being used. Not being able to easily and uniformly identify such scholarship through shared language limits the capacity for counter-hegemonic action against this conceptual hydro-hegemony.

*Fragmentation and Equivocality*
The impact of the above bodies of law and policies on virtual water is vague at best. International law must be written and approved by multiple actors and multiple levels; ambiguity may be a political necessity in getting treaties passed (Fischhendler, 2008). But when law is open to interpretation, it seems likely that it will be interpreted in favour of the powerful.

Part of law’s equivocality on virtual water is the result of fragmentation. Global water governance frames water alternately as an environmental problem, an economic concern, and a human rights matter. This creates legal fragmentation, such that it is not clear where responsibility for monitoring water lies, which agreements have precedence, etc. (Urueña, 2009). Numerous treaties and areas of law not discussed above could also be relevant to a virtual water trade: environmental and climate change law, regional agreements, domestic laws, private sector regulation, etc. Urueña argues that this fragmentation can be seen, not as a problem or source of anxiety and confusion, but as an opportunity to be creative in finding solutions that traditional law cannot provide.

Three case studies of virtual water flows will be presented. The **Conclusion** will then consider how the fragmented legal regimes discussed above are and could be impacting those flows, and how trade parties could be creative in addressing virtual hydro-hegemony.
Peruvian Asparagus in the UK

Each year, the United Kingdom consumes some 3,600 Olympic swimming pools’ worth (nine million cubic metres) of Peruvian water via the more than seven thousand tonnes of asparagus it imports (Hepworth et al., 2010: 3, FAOSTAT, 2013). The bulk of this asparagus “is grown intensively in large blocks of land reclaimed from the desert, irrigated by groundwater delivered by drip irrigation through hundreds of kilometres of pipeline. In 2002 this greening of the desert became unsustainable, when the irrigation needs of asparagus began to push the exploitation of the valley’s aquifer into the red” (Hepworth et al., 2010: 3).

While the state-level accusations based on international law presented in the fictional news story introducing this paper are false, the idea of British people “eating Peru’s water” and local Peruvians’ water security being harmed by commercial asparagus trade is true (Hepworth et al., 2010). Multiple UK news stories have critiqued big businesses for the market, especially in Evesham, a town famous for its asparagus production and annual festival (Lawrence, 2010, Poulter, 2010, Telegraph, 2010). But the UK continues to buy, Peru continues to grow, and virtual water continues to flow.

Domestic Endowment

The Peru-UK asparagus case is particularly striking because of the very obvious inequality in local water resources. Ica, where the majority of Peruvian asparagus is grown, receives 0.6 millimetres of rainfall per year, in contrast to the UK’s 1,126 mm (Hepworth et al., 2010: 19). Figures 5 and 6 illustrate the different growing conditions for asparagus in the two countries.

This case highlights the need for micro-level analysis in virtual hydro-hegemony studies. The proxy indicators used to plot VHH are macro-level statistics. The Domestic
Endowment differential between the Peru and UK is not as striking at the country level. Were the comparison plotted for the specific locations where the majority of asparagus is grown, the inequalities in trade power would be even more apparent.

**Material Power**
The UK’s population is more than twice that of Peru’s, but its GDP is more than seven times larger and its military budget more than fifteen (World Bank, 2013, CIA, 2013). In terms of hard power via brute strength, the UK is a clear comparative hegemon.

**Bargaining Power**
Peru’s economy is more dependent on agriculture than the UK’s, and the asparagus trade has brought badly needed jobs to the Ica region (Hepworth et al., 2010). However, Peru has more water resources available, and uses less of the water it does extract for agriculture than the UK does. Both can make claims to international law to solve trade disputes, though the UK has a greater array of trade alternatives via the European Union. The two actors each hold a decent amount of bargaining power, with the UK holding a slight advantage.

**Ideational Power**
The UK’s influence on the global stage is far greater than Peru’s. The UK has more invested in research and development, publishes more research, and has greater influence in the UN. Perhaps most critically to this case study, the UK currently sends foreign aid to Peru. These ties inevitably give the UK a far stronger position in shaping Peruvian agendas and narratives than vice versa.

**Virtual Hydro-Hegemony**
**Figure 7** plots the pillars of Peru’s and the UK’s VHH relative to each other. The UK is a clear virtual hydro-hegemon with an estimated relative influence of 12.5:3.5 over Peru.
The UK’s virtual hydro-hegemony over Peru does not necessarily mean that Peru is being forced to export asparagus, or that the asparagus trade is an entirely negative thing for the Andean country. Possible interpretations and consequences of this virtual hydro-hegemony will be discussed in the Conclusions section, with comparisons made to the other case studies.
US Cereals in Egypt

Egypt annually imports some 11 trillion cubic meters of virtual water, making it reliant on foreign supplies for nearly one-fifth of its total water footprint, the water used to produce goods and service consumed by the state (Hoekstra and Chapagain, 2008: Appendices). In 2005, Egypt was “already dependent on virtual water imports, and there is no necessary reason why it could not shift further in that direction” (Selby, 2005: 340-341). US cereals, primarily wheat, account for a huge proportion of this VW import: The Arab country imports more than 1.5 million tonnes of US cereals a year (FAO, 2013).

Egypt, perhaps more than the average country, is aware of and concerned about its food and VW imports. Reliance on others has a strong negative connotation: “it is perceived by Egypt that dependence on food imports will lead to giving in to foreign domination” (el-Sadek, 2010: 2444). The vulnerability of food-importing states to global food prices also seems to be a greater issue for Egyptian state security. The 2008 global food price spike led to rioting (Weber and Harris, 2008). Egypt’s government responded in contradicting ways, discussing the need for agricultural self-sufficiency while also focusing on importing even more food during times of stress. 2011 saw another round of food-related stress (Le Coq, 2011), this time combining with other political and economic woes to result in the overthrow of Mubarak’s government. Cereal imports continue to be an important piece of overall trade relations and food security, however.

**Domestic Endowment**

The US has far more favourable agricultural conditions than Egypt. Greater water resources, more arable land, heavier precipitation, and lower evapotranspiration rates all combine to give the US a comparative advantage in agricultural production.

**Material Power**

The US has more material power than Egypt, with a significantly higher total GDP and GDP per capita, a larger and stronger military, and greater technical advancement.
**Bargaining Power**

Egypt relies on cereal imports to meet domestic demand. This greatly diminishes its bargaining power, but its status as a member of the UN and WTO, along with its strong position in the Arab bloc, ensure it has some bargaining power, albeit less than the US’. The imbalances in material and bargaining power have been amplified since the uprisings of 2011, as Egyptian leadership has been unclear and regime agendas contradictory.

**Ideational Power**

As a relative hegemon in the Arab world, Egypt has some ideational power, particularly via influence in the UN and similar bodies. However, the US is able to invest and produce far more in research and development, contributing to global knowledge and shaping global discourse. The US sends significant aid to Egypt (indeed, some of the cereal trade is framed as aid), gaining ideational power through aid conditionalities and consequent relationships.

**Virtual Hydro-Hegemony**

**Figure 8** plots US’ VHH over Egypt. This VHH imbalance is even greater than the Peruvian-UK case, with a ratio of 14.5:1.5 in the US’ favour, but in the opposite flow direction. Why this is and what it means will be considered in **Conclusions**.
Israeli Agriculture in the European Union

A central goal of Zionism’s efforts in the Palestinian land was to “make the desert bloom” (Frey and Naff, 1985: 75-76). Agricultural success was seen as a way to legitimise the Jewish claim to the land using the logic of the Berlin Conference’s “effective occupation” principle (Berlin Conference, 1885). The desert country’s “emergence as an agricultural country was a matter of choice” (Tal, 2007: 228) rather than natural comparative advantage, encouraging the country to become a pioneer in water use infrastructure and policy (Organisation for Economic Co-operation and Development, 2011: 104). Though Israel is a net VW importer, ranking twenty-fifth globally in 2002 (Hoekstra and Hung, 2002: 26), the country’s VW exports are significant to trade relations. The country has an Association Agreement with the European Union allowing for trade liberalisation, agricultural trade between the two was expanded by a joint agreement in 2009 (European Union, 2009). The EU is Israel’s second largest export market, only behind the United States (European Commission, 2013a), and imports more than one billion euros’ worth of Israeli agricultural products annually (European Commission, 2013b).

**Domestic Endowment**
The EU clearly has a comparative advantage in agricultural production over Israel: Israel has less water, less land, less rainfall, and higher evapotranspiration rates.

**Material Power**
But the two actors are evenly matched for material power. Israel makes up for its lack of domestic endowment with significant technical prowess. Both actors have developed economies with large military capacities.

**Bargaining Power**
Though Israel’s economy is not heavily dependent on agriculture and it can make some international law claims, the state is a pariah to most of its neighbours. Limited trade alternatives and increasing pressures on its already stressed water supply diminish Israel’s bargaining power.
Ideational Power

Israel employs its technical expertise in irrigation and water efficiency technologies for diplomatic relations. It spends a greater proportion of its wealth on R&D than the EU, though its smaller size results in fewer total published articles. Though neither actor is reliant on the other for aid, the EU has greater influence in the UN and similar organisations due to its voting bloc power in the midst of continuing anti-Israeli sentiment from some countries.

Virtual Hydro-Hegemony

Israeli-EU VHH is plotted in Figure 9. The EU is a virtual hydro-hegemon with a power ratio of 11.5:4.5 compared to Israel, making this trade relation the least extreme case of VHH under consideration.

Figure 9. Israeli-EU Virtual Hydro-Hegemony
Conclusions

*Virtual Water Allocations and Hydro-Hegemony*

Access to water goes far beyond farmers waiting their ‘turn’ for irrigation water. Allocations of food start far before queues at a market. Global water, food, and economic systems intersect to create an intricate system that influences and is influenced by access and allocation at every scalar level. The Earth systems governance framework enables us to better consider the connections between these systems and the power relations, knowledges of and norms behind these issues.

This paper has demonstrated that certain forms and understandings of water gain prominence in academic literature, research agendas, and policy goals via conceptual hydro-hegemony. Through conceptual hydro-hegemony, virtual water is given less consideration than blue water. This prioritisation results in large volumes of virtual water flows internationally without full consideration given to the impacts of those flows. International law does not explicitly consider virtual water; this lack reflects and reproduces non-attention to VW concerns in trade policy and earth systems governance.

Material, bargaining, and ideational power combine with local endowments to form virtual hydro-hegemony. This paper’s case studies on Peruvian asparagus exported to the UK, American cereals sent to Egypt, and Israeli agricultural products imported by the EU provide several lessons for virtual hydro-hegemony considerations.

- Power relations strongly influences virtual water allocations.
  - Virtual hydro-hegemony is strongly apparent in multiple examples of virtual water trade with vastly different hydrological, economic, and political realities, even between formal equals.
  - VHH is not unique to import or export conditions. VW hegemonic actors may be at either end of a virtual water flow. The economic assumption that liberal trade will result in comparative advantage production cannot adequately explain virtual water allocations.
- Knowledge of virtual water continues to be limited.
  - VW flows are often not considered by participating parties as such. This makes VHH all the more powerful, as it often goes unacknowledged or
considered. Rendering visible seemingly ‘invisible’ virtual water continues to be one of the greatest priorities in countering virtual hydro-hegemony.

- The cases considered focused on one specific form of virtual water flow, but trade partners often exchange multiple types of goods bi-directionally. When considering VW in trade policies and laws, states must examine entire trade portfolios.
- VW is only one component of a trade. Parties may gain valued goods, jobs, political influence, etc. when trading away virtual water. This is not necessarily a problem, but quickly becomes so when the VW costs of trade are not considered and VHH amplified.

- Scale matters.
  - Macro and micro level scalar analyses are both necessary in informing VW considerations. While Peru as a country has greater water resources than the United Kingdom, the Ica Valley is much drier. This makes the asparagus trade a greater VW injustice than if the asparagus were produced in a more water-rich area of Peru.

- Norms can be used to reproduce or challenge power inequalities.
  - Even non-hegemonic actors generally have decent levels of bargaining power. This gives international law – and its stance on virtual water – a particularly important place in VHH considerations, as IL is a core component of bargaining power.

*International Law and Virtual Hydro-Hegemony*

International law is presently subject to conceptual hydro-hegemonies such that virtual water is not explicitly considered. International law does not specifically govern virtual water; any impact IL has on VW flows is incidental. This paper’s case studies suggest several ways to better consider VW in international law or utilise IL to push against VHH.

- International trade law governs each of the trades considered in this paper’s case studies. International human rights law and international water law may not be relevant or enforceable in each of the cases, but they do shape bargaining and
ideational power. Appeals to human rights, for example, can bring attention to unequal VW trades, placing pressure on virtual hydro-hegemons.

- The US, a strong virtual hydro-hegemon, sends vast amounts of VW to Egypt via cereal exports. These VW flows sometimes take the form of foreign aid, and may thus provide the US with unspoken controls over Egypt in exchange. Counter-hegemonic action might focus on ensuring VW flows – especially those from a virtual hydro-hegemon – are formal trade agreements so both parties are aware of what is expected to be given and received. Formal trade agreements are subject to international law in ways unilateral aid is not. This may provide extra protection for the non-hegemonic party.

- Naming virtual water quantities in trade agreements so that both countries know and agree upon VW flows can formalise the trade as one including VW and ensure that information about VW flows is symmetric.

- Countries should reconsider allowing for discrimination against the process as well as the product in international trade law. This was not permitted under the GATT in the Tuna-Dolphin Case, but VW concerns are inherently ones of process. Global conversations about how this should be addressed are needed.

- Pricing virtual water through import and export tariffs may be one solution to better accounting for and valuing VW flows. Countries can consider VW export quotas so that limited amounts of water are sent out.

- The above solutions reinforce the conceptually hydro-hegemonic idea of water as an economic good and should thus be deliberated carefully. States should consider whether VW should be treated as a good, a process, or something else entirely under international law.

**Future Directions for Action and Research**

The Earth Systems Governance Framework provides a clear suggestion for further exploration around these topics: Problems of architecture, agency, adaptiveness, and
accountability around virtual water flows need to be more fully addressed. The original Framework of Hydro-Hegemony was meant to be prescriptive, providing an “analytical paradigm useful for examining the options of such powerful or hegemonized riparians and how they might move away from domination towards cooperation” (Zeitoun and Warner, 2006: 435, emphases added). This paper’s expanded Frameworks are also meant to be prescriptive, serving as ways to identify and critique the status quo and determine how unjust allocations might be countered for more equitable access. These Frameworks can continue to be blended with the ESG Framework to consider some of the issues highlighted below.

Agriculture continues to have a conceptual hydro-hegemony in virtual water scholarship, even as virtual water is counter-hegemonic to mainstream foci on blue water. More work needs to be completed on water footprinting and related techniques; considering the virtual water present in services, manufactured goods, and the like; and integrating virtual water into conventional water science.

Lawyers and international relations scholars need to consider virtual water. International water law needs to move beyond regulating blue water, and legal fragmentation around water needs to be rectified so that all forms of water are considered holistically.

Beyond topical concerns, more scholarship from non-hegemonic perspectives is needed. The majority of virtual water scholarship comes from Western authors and institutions. Dominant discourses frame virtual water as a way for water-poor states to improve their food and water security, but this rationale is itself informed by political motivations. This paper’s author is the subject of Western training and teaching about water, trapped by conceptual hydro-hegemonies she does not even see. Alternate perspectives are needed to inform counter-hegemonic action and better understand virtual hydro-hegemony.

International law around virtual water is currently equivocal, but it can be shaped and made into a powerful tool of bargaining power for non-hegemons. If weaker parties in virtual hydro-hegemonic relationships can see beyond conceptual hydro-hegemony, they can create an entirely new array of tools by which to counter virtual and other hydro-hegemonies.
References


Appendix A. Plotting Virtual Hydro-Hegemony

The four pillars of Virtual Hydro-Hegemony were plotted for each actor in the trade relation. VHH powers were considered relative to the other party in a trade, determined by evaluating the related criteria listed below. Actors were given scores of 0, .5, or 1 for each criterion based on proxy indicators (Tables 1-6); the four sub-scores were summed to inform a rating of 0-4 for each pillar for each actor (Tables 7-18).

For Domestic Endowment:

- **Renewable Water Resources**: Composite Comparison of Renewable Water Resources and Renewable Water Resources per Capita
- **Arable Land**: Direct Comparison of Arable Land
- **Precipitation**: Direct Comparison of Precipitation
- **Evapotranspiration Rate**: Direct Comparison of Estimated Average Evapotranspiration Rate

For Material Power:

- **GDP**: Direct Comparison of GDP
- **GDP per Capita**: Direct Comparison of GDP per Capita
- **Military Expenditure**: Composite Comparison of Military Expenditure (% GDP) and Military Expenditure (billion USD in PPP)
- **Technical Advancement**: Composite Comparison of % GDP from Industry; % GDP spent on Research and Development; # Scientific and Technical Journal Articles Published; and General Knowledge

For Bargaining Power:

- **Economic Reliance on Agriculture**: Composite Comparison of % GDP from Agriculture; % Freshwater Extracted used Agriculturally; and VW Trade Volumes
- **Water Availability**: Composite Comparison of Renewable Water Resources; Renewable Water Resources per Capita; Precipitation; Freshwater Withdrawal; and Freshwater Extracted per Capita
- **International Law Claims**: Consideration of Actors’ Positions in UN and WTO and Germaine International Law
• *Availability of Trade Alternatives*: Consideration of Actors’ Positions in OECD, UN, WTO, etc.; Regional Trade Agreements; Other Trade Partners; and VW Trade Volumes

For Ideational Power:

• *R&D Expenditure*: Direct Comparison of % GDP spent on Research and Development

• *Journal Articles Published*: Direct Comparison of # Scientific and Technical Journal Articles Published

• *Influence in the UN*: Consideration of Security Council Position; Regional and Other Agreements/Blocs; and Allies

• *Foreign Aid*: Consideration of Foreign Aid Flows between Trade Partners

**Tables 1-6** contain the proxy indicator data relevant to this paper’s three case studies. **Tables 7-18** show the scores awarded based on this proxy indicator data that were used in plotting VHH.

**Table 1. Domestic Endowment Indicators** (CIA estimates, 2011)

<table>
<thead>
<tr>
<th></th>
<th>Renewable Water Resources (km^3)</th>
<th>Renewable Water Resources per Capita (m^3)</th>
<th>Precipitation (mm/year, World Bank)</th>
<th>Estimated Average Evapotranspiration Rate (mm/day, FAO)</th>
<th>Arable Land (%)</th>
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<tr>
<td>Egypt</td>
<td>57.3</td>
<td>671.7909741</td>
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<td>230.9576099</td>
<td>435</td>
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<td>64088.59865</td>
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<tr>
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<td>1220</td>
<td>1-3</td>
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<tr>
<td>US</td>
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<td>9691.520788</td>
<td>715</td>
<td>2-4</td>
<td>16.29</td>
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**Table 2. Population and Military Expenditure** Indicators (World Bank estimates, 2011)

<table>
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<tr>
<td>Egypt</td>
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### Table 3. GDP Indicators (CIA estimates, 2012)

<table>
<thead>
<tr>
<th></th>
<th>GDP (billion USD in PPP)</th>
<th>% GDP from Agriculture</th>
<th>% GDP from Industry</th>
<th>% GDP from Services</th>
<th>GDP per Capita (USD in PPP)</th>
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<tr>
<td>Egypt</td>
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### Table 4. Freshwater Use Indicators (CIA estimates, 2000s)

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<tr>
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<th>Freshwater Withdrawal (km³/year)</th>
<th>Freshwater Extracted per Capita (m³/year)</th>
<th>% Freshwater Extracted used Agriculturally</th>
<th>% Freshwater Extracted used Industrially</th>
<th>% Freshwater Extracted used Domestically</th>
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<td>1583</td>
<td>14</td>
<td>46</td>
<td>40</td>
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### Table 5. Virtual Water Trade Volumes (Mekonnen and Hoekstra estimates, 2011)

<table>
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<tr>
<th></th>
<th>Net Virtual Water Import (Blue Water)</th>
<th>Net Virtual Water Import (Green Water)</th>
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### Table 6. Ideational Power Indicators (World Bank estimates, 2000s)

<table>
<thead>
<tr>
<th></th>
<th>% GDP spent on Research and Development</th>
<th># Scientific and Technical Journal Articles Published</th>
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Table 7. Peru & UK Domestic Endowment Scores

<table>
<thead>
<tr>
<th></th>
<th>Renewable Water Resources</th>
<th>Arable Land</th>
<th>Precipitation</th>
<th>Evapotranspiration Rate</th>
<th>VHH Pillar Score</th>
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<tbody>
<tr>
<td>Peru (Exporting Country)</td>
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<td>UK (Importing Country)</td>
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Table 8. Peru & UK Material Power Scores

<table>
<thead>
<tr>
<th></th>
<th>GDP</th>
<th>GDP per Capita</th>
<th>Military Expenditure</th>
<th>Technical Advancement</th>
<th>VHH Pillar Score</th>
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<tr>
<td>Peru (Exporting Country)</td>
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<td>UK (Importing Country)</td>
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Table 9. Peru & UK Bargaining Power Scores

<table>
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<tr>
<th></th>
<th>Economic Reliance on Agriculture</th>
<th>Water Availability</th>
<th>International Law Claims</th>
<th>Availability of Trade Alternatives</th>
<th>VHH Pillar Score</th>
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Table 10. Peru & UK Ideational Power Scores

<table>
<thead>
<tr>
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<th>Journal Articles Published</th>
<th>UN Influence</th>
<th>Foreign Aid</th>
<th>VHH Pillar Score</th>
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<tr>
<td>UK (Importing Country)</td>
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Table 11. US & Egypt Domestic Endowment Scores

<table>
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<th>Arable Land</th>
<th>Precipitation</th>
<th>Evapotranspiration Rate</th>
<th>VHH Pillar Score</th>
</tr>
</thead>
<tbody>
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Table 12. US & Egypt Material Power Scores

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Table 13. US & Egypt Bargaining Power Scores

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<th>VHH Pillar Score</th>
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Table 14. US & Egypt Ideational Power Scores

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<th>Journal Articles Published</th>
<th>UN Influence</th>
<th>Foreign Aid</th>
<th>VHH Pillar Score</th>
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**Table 15. Israel & EU Domestic Endowment Scores**

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<th>Arable Land</th>
<th>Precipitation</th>
<th>Evapotranspiration Rate</th>
<th>VHH Pillar Score</th>
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</thead>
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<tr>
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**Table 16. Israel & EU Material Power Scores**

<table>
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<th></th>
<th>GDP</th>
<th>GDP per Capita</th>
<th>Military Expenditure</th>
<th>Technical Advancement</th>
<th>VHH Pillar Score</th>
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<tbody>
<tr>
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<tr>
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**Table 17. Israel & EU Bargaining Power Scores**

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**Table 18. Israel & EU Ideational Power Scores**

<table>
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