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Analysis

How Does Virtual Water Flow in Palestine? A Political Ecology Analysis

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ABSTRACT

There is an exhaustive literature on Israel, Palestine and water, which has documented how the asymmetric power of Israel in the Oslo negotiations ensured its control of land and water over Palestine. Less attention however has been paid on the interface of water, trade and agriculture, and the ways in which controlling trade, Israel controlled the virtual flows of water too. The concept of virtual water makes the water-agriculture-trade relationship visible, shedding light on agricultural trade flows in terms of water. Applying a political ecology approach, this paper shows how socio-ecological conditions are sustained by and organised through both social and metabolic-ecological processes. A biophysical analysis - the agricultural flows of virtual water from and to Palestine in the Post-Oslo period - is combined with the examination of the power relations that governed these flows. The analysis reveals that virtual water flows are not static but instead evolve within the (geo)political-economic context in which they are embedded, bringing to light Israel's control over the flow of Palestinian agricultural virtual water. We argue that a political ecology approach to virtual water offers a theoretical basis to move beyond the currently techno-managerial emphasis in the virtual water literature, illuminating the link between the control of virtual flows and the consolidation of political and economic power.

1. Introduction

A core contribution of ecological economics is the identification and assessment of the hidden resource and energy flows that sustain final consumption. Ever since Howard Odum's (1973) conceptualization of 'Emergy', that is the energy embedded in final goods and services, ecological economists have been on the forefront of developing new indicators and quantifying the 'rucksacks' and the indirect material flows that sustain an economy. Concepts such as the 'ecological footprint' (Rees, 1992), the water footprint (Hoekstra and Hung, 2002), or the material footprint of nations (Wiedmann et al., 2015) have their origins in the conceptual innovation of ecological economics in seeing the economy not as the aggregation of monetized goods and services within the borders of a single country, but as the totality of energy and materials that support the production and consumption of a social system. Virtual water (VW) is an indicator that reflects the hidden water flows of social metabolism (Martinez-Alier, 2005). VW refers to the amount of water required for the production of a good or service (Allan, 2001). Whereas ecological economists have contributed to the quantification of the virtual water moved through trade and the water footprint of nations or regions (Aldaya et al., 2010, Ercin et al., 2013), they have paid less attention in elucidating the political and economic dynamics that govern these hidden flows of water.

The study of power relations and the way they affect access to and use of resources, and the distribution of environmental goods and bads, is the domain of political ecology. Political ecology and ecological economics are 'sister' communities that have evolved together (Martinez-Alier et al., 2010). In the spirit of integrating further political ecology with ecological economics (see Martinez-Alier et al., 2010, Kallis et al., 2013), this article advances a political-ecological economic approach to the study of virtual water, quantifying hidden flows, while contextualising them and explaining them by understanding political and power dynamics (Beltrán and Velázquez, 2015).

Palestine is an emblematic place for studying power and water. The role of water in the Palestinian-Israeli conflict has been analysed by Kally and Fishelson (1993), Lonergan and Brooks (1994), Elmusa (1997), Selby (2003a, 2003b, 2011, 2013), Trottier (1999, 2007), Zeitoun (2008) and Glover and Hunter (2010), to name a few, who argue that the asymmetric power of Palestine in the Oslo negotiations has ensured Israel's domination over water allocation in Palestine. Studies have also shown how Israel-Palestine trade relations have influenced the deterioration of Palestine's agricultural productive capacities, resulting in the decline of the agricultural sector's contribution to the economy (de Pascale, 1996; Cottier and Paunatier, 2000; Haj Khalil, 2009; Taghdisi-Rad, 2011). Despite this exhaustive literature on Israel, Palestine and water, less attention has been paid on the interface of

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water, trade and agriculture, and the ways in which controlling trade, Israel may have controlled the virtual flows of water too.

The concept of virtual water, developed by Allan (2001), is extremely useful to make this water-agriculture-trade relationship visible, as it sheds light on agricultural trade flows in terms of water. Allan (ibid.) promoted this term to underline how Middle Eastern countries' water requirements have exceeded available resources since 1970. In other words, water scarcity in these countries was being managed by importing VW in the form of agricultural products from the international market. While VW was defined as a theoretical indicator, the water footprint (WF) emerged from the methodological attempt by Hoekstra and Hung (2002) to estimate VW, defined as the "volume of water needed for the production of the goods and services consumed by the inhabitants of the country" (Chapagain and Hoekstra, 2004, 11). Amidst many other methodologies (see Velázquez et al., 2011 for an overview), WF remains the most widespread. Suffice to say that VW and WF have been popularised and numerous studies on virtual water flows of economies worldwide have shown the increase in virtual water trade around the world (Chapagain and Hoekstra, 2004; Chapagain et al., 2006; Hoekstra and Chapagain, 2008).

In terms of the Palestine case, previous studies have implemented methodologies capable of estimating VW flows in the West Bank (Nazer et al., 2008) and quantifying the effects of VW trade on water management in Palestine (Nassar, 2007; Hamdi, 2014). However, there is an ongoing debate over the contradictions generated by the VW indicator when it comes to providing information for implementing water and trade policies (but see Wichelns, 2010, 2011, 2015). And most analyses on VW flows are undertaken from a quantitative perspective while the wider socioeconomic and environmental context is absent (Chenoweth et al., 2014).

In light of these gaps, we propose that a political ecology approach to VW offers powerful theoretical bases to contextualise and politicise environmental knowledge (Forsyth, 2003). Political ecologists recognize the biophysical roots of environmental problems, but also focus on the link between ecological problems and their political dimension showing how socio-ecological conditions are sustained by and organised through both social and metabolic-ecological processes (Swyngedouw, 2006). In this vein, we argue that the estimation of VW flows should be explained considering the political, social and territorial implications of these flows – that is, who benefits and who suffers from VW flows, or non-flows. This approach means that VW flows are not just the flow of a resource, but the manifestation of the political and social relations that exist between water, agricultural production and trade in the Palestinian Territories.

The purpose of this paper is thus twofold. Firstly we examine the social and political mechanisms that affected the flow of agricultural VW in Palestine during the Post-Oslo period. Secondly, we quantify these VW flows and then relate them to their broader social and political context. The analysis reveals that VW flows evolve along with the political context in which they are embedded, bringing to light the power geometries that affect the flows of VW.

The findings suggest that Israel reduced the flow of Palestinian agricultural virtual water exports and diverted virtual water imports from Palestine to itself. This contextualised VW approach illuminates the link between the control of VW flows and the consolidation of Israeli political and economic power over Palestine through water.

This paper, in this light, explores the relevance of combining biophysical analyses with the examination of institutional and political relations that both coexist with and affect virtual water flows. Following this introduction, the second section describes key elements in the Oslo Protocol, the Peace agreement signed between Israel and Palestine in Oslo in 1993, and how this affects water, land governance and agricultural trade. The third section unpacks VW and the methodology we used to estimate it, explaining how VW can be approached from a political ecology perspective. The fourth section presents the quantitative analysis of Palestinian agricultural VW flows from 1997 to 2013 and examines how the political and social context has conditioned these flows. The per capita agricultural virtual water imports and exports of the Palestinian Territories are compared to those of the adjacent countries (Israel, Jordan, and Egypt) in order to provide a regional perspective on the Palestinian case. Section 5 draws conclusions from this research and what it contributes to the study of virtual water and political ecology.

2. The Oslo Agreement: The Economic Dimension of Peace

The controversial application of the Peace Agreement signed in Oslo between the Palestinian Territories and Israel in 1993, initially planned for five years and subsequently extended, marked a crucial turning point in Palestine history. Analyses of this framework which has since governed Israeli-Palestinian relations have shown the vital role trade has played in the survival of the Palestinian economy as well as the latter's long term dependence on Israeli policies (Arnon and Bamya, 2015; Office of the Quartet Representative, 2013). The economic effects of restricted access to land in the West Bank and of restrictions on Palestinian water sector development have, furthermore, been significant (United Nations Conference on Trade and Development [UNCTAD], 2011, 2012a; World Bank, 2009a, 2010). These studies, alongside those looking at Israeli imposed movement restrictions within the West Bank (UN Office for the Coordination of Humanitarian Affairs [OCHA], 2011), illustrate the importance of Palestine's agricultural sector for socio-economic development and poverty reduction within complex Israeli regulations and procedures that have ultimately undermined the development of Palestinian agriculture (UNCTAD, 2012a).

The Paris Protocol, signed in 1994, was part of the Oslo Agreement, and was designed to serve as a temporary protocol on economic relations between Palestine and Israel. More than twenty years after the implementation of this Protocol the overarching objective of the Israeli Authorities to ensure control over the Palestinian Territories has taken the form of an imposed trade integration between these two countries. By ensuring that Israeli exports flow smoothly to Palestine while Palestinian exports to Israel and other countries are controlled, Israel preempts any possible competition between Palestinian and Israeli producers (Taghdisi-Rad, 2011).

The agricultural sector has not been an exception; restrictions to land and water resources as a result of Israeli policies have had long-term implications for Palestinian agricultural production in general and for agricultural trade in particular. The creation of administrative Areas (A, B and C) in the West Bank dictating Israeli and Palestinian Authority powers under the Oslo process and import-export policy have led to significantly increased trading costs and reduced mobility for Palestinians; these realities have a comparatively greater impact on agricultural trade due to its time-sensitivity. To lay bare these issues we briefly examine three different aspects of the Oslo Accords: 1) Palestinians' land access and movement; 2) Israeli-Palestinian water governance relations and 3) Israeli-Palestinian agricultural trade relations. We will then illustrate how these three aspects influence the performance of the Palestinian agricultural sector, before exploring how these factors influence agricultural VW flows.

2.1. Administrative Areas in the West Bank: Palestinian Mobility and Land Access

The Oslo Accords, signed in 1993 and 1995, were intended to temporarily divide the West Bank into three administrative zones, called areas A, B, C (see Map 1). Area A, 18% of the West Bank land area, consists mostly of the main towns such as Ramallah, Hebron, Bethlehem and Jericho under full Palestinian Authority (PA) civil and security control. In Area B, around 22% of the West Bank, the PA has control over civilian services such as planning, but only joint security control with the Israeli military. Area C is the largest administrative area of the West Bank,

comprising 60% of the territory, and is under full control of the Israeli Civil Administration. Part of the Coordinator of Government Activities in the Territories, the Civil Administration was established by the Government of Israel in 1981 as a unit of the Ministry of Defense in order to carry out practical bureaucratic functions within the territories occupied in 1967. In Area C, the Israeli government has control over Palestinian land and imposes restrictions to the construction of water infrastructure and agriculture expansion.

During the Second Intifada (2000–2004), the second Palestinian uprising against Israel also known as the Al-Aqsa Intifada,[1] Israel tightened movement policies and built the West Bank wall, severely restricting Palestinians' land access. The creation of the wall, Israeli settlements and road barriers have led to the requisition of 7884 dunums[2] (788 ha) of land throughout the West Bank from 2005 to 2006 alone (Taghdisi-Rad, 2011).

The effect of the administrative Areas on Palestinians´ land access and movement is exemplified in the Jordan Valley. Almost 45% of total Palestinian irrigated areas in the West Bank are concentrated in the Jordan Valley region (Palestinian Central Bureau of Statistics [PCBS], 2009b). It is considered one of the areas of highest agricultural potential in the Palestinian Territories and also one of the most restricted areas in terms of freedom of movement on earth (Paltrade, 2010). Ninety four percent of the Jordan Valley is off limits for Palestinian development (OCHA, 2012a). Access to the Jordan Valley is controlled through numerous checkpoints and the West Bank barrier, restricting the movement of Palestinian vehicles. Within the Jordan Valley there are 37 Israeli settlements with a population of 9500 inhabitants, settlements that contravene international law (ibid.). Sixty nine percent of water extractions in the West Bank by the Israeli national water company Mekorot come from Israeli wells in the Jordan Valley (ibid.). These wells primarily serve Israeli settlements and their agricultural production.

2.2. Israeli-Palestinian Water Governance

While the Peace Agreement signed in Oslo in 1993 offers only a brief treatment of water issues, the Israeli-Palestinian interim arrangement for the development and use of Palestinian water resources signed in 1995, known as Oslo II, established an elaborate framework for the allocation and management of shared water resources (Article 40). Previous to this framework, concretely following 1967 war, water use and access in the West Bank had been regulated through several Military Orders[3] that granted Israel complete authority over all issues concerning water in the Occupied Territories (Trottier, 2007). The implications of Oslo II on the availability of water resources to Palestinians have been thoroughly examined (Hillel, 1994; Lonergan and Brooks, 1994; World Bank, 2009b; Brooks and Trottier, 2010, 2012; Selby, 2003a, 2003b, 2011, 2013), showing principally that this framework has failed to ensure efficient, equitable and sustainable water management in the long term.

The Jordan River is the main source of surface water in the area, but the river is currently an Israeli military zone and Palestinians have no access and thus no water directly from the Jordan River (Friends of the Earth Middle East, 2012). Regarding groundwater, Article 40 established that the requirements for fresh water would be divided between immediate and future needs of the occupied Palestinian Territories. Immediate needs, for example, allocate 29 cubic hectometres (hm^3) for Palestinians, 23.6 hm^3 for the West Bank and the rest for Gaza Strip. Regarding future needs, the Palestinian supply, according to the projections done in 1995 as part of the Oslo Agreement, should increase 70–80 hm^3 per year above 1995 consumption levels (Brooks and Trottier, 2012).

During the five-year "interim arrangement", still in place over fifteen years later, water-related decisions had to be taken by Israeli and PA consent. An Israeli-Palestinian Joint Water Committee (JWC) was established and given the authority to regulate the use of water resources in the Palestinian territory. However, despite the existence of Palestinian representation on the JWC, Israel has been able to veto or delay water-related projects, resulting in the rejection and delay of dozens of water projects submitted by the PA (OCHA, 2012b). Furthermore, the Agreement established that JWC had the right to control water quotas on Palestinian wells, imposing the quota as the maximum consumption level of the wells in 1995.

Among the many criticisms this Agreement has received, Brooks and Trottier (2010) highlight that its fundamental flaw is that it treats water from a quantitative approach, as if it were as immobile as land. Sharing water under this approach has implied the securitisation of the resource and a rigidity that prevents the system from adjusting to natural changes or to socio-economic developments. Selby (2003b, 21) argues for the complete restructuring of this Israeli-Palestinian water 'cooperation' agreement, because it involves "domination dressed up as 'cooperation'". He furthermore concludes that under the terms of the Oslo II agreement Israel has achieved large absolute and per capita increases in water supply, including large increases for both domestic and agricultural use, facilitating Israel's expansionist territorial and settlement interests within the West Bank (Selby, 2013). In contrast, Palestinian water production within the West Bank has dropped overall by 20 hm^3 per year since 1995. This absolute decline in internal water production has been partially compensated by an increase in water purchases from Israel of over 100% (ibid.).

The decline in internal water production combined with increased dependency on water supplies from Israel and with the land requisition policies mentioned above has undermined Palestine's agricultural production capacities, resulting in the decline of the Palestinian agricultural sector's contribution to the economy. Between 1995 and 2008 the share of agriculture in GDP declined from 12% to a mere 5% (UNCTAD, 2012a). Agricultural growth is limited by land and water availability as well as the expansion of Israeli settlements. Although from 1997 to 2008 the population of the Palestinian territories increased 72%, the total cultivated land area remained fairly constant (PCBS, 2009b). Agricultural intensification was also limited mainly due to the lack of access to markets which itself was a result of inefficient and high production costs caused by lack of access to pesticides, equipment and agricultural subsidies (Taghdisi-Rad, 2011).

2.3. Israel-Palestine Trade Relations: The Paris Protocol and Hidden Distortions

The Palestinian trade structure has been heavily dependent on Israel since 1967 as the source or channel for exports and imports. Official statistics suggests that Israel is the source or channel for about 80% of imports and absorbs about 90% of Palestinian exports (UNCTAD, 2011). Since its signing in 1994 as part of the Oslo Accords, the Protocol of Economic Relations, also called the Paris Protocol has ensured the long term dependence of Palestinian trade on Israeli policies. The element of interest in the Paris Protocol regarding agricultural trade (article VIII of the Protocol) is import and export policy.

The Paris Protocol, beyond its 'temporary' (five-year) framework, continues to serve as the governing framework for economic relations

[1] The Second Intifada broke out at the end of September 2000, following a visit by Israel's then-opposition leader Ariel Sharon to Jerusalem's Temple Mount. After seven years of the Oslo peace process, negotiations had failed to deliver a Palestinian state and Palestinian discontent was intensified by the collapse of the Camp David summit in July 2000. No definitive ending date can be assigned to the Second Intifada, though some would place the end at February 2005. The determinants of Palestine's economic performance in the post Second Intifada period have been analysed by Taghdisi-Rad (2011).

[2] Dunum is a traditional unit of land area in the Middle East, still commonly used today in Israel and Palestine. The dunum is a metric unit equal to 0.1 ha.

[3] For an extend analysis of the power relations over access to water resources in the Palestinian Israeli conflict in the pre-Oslo period see Trottier (2007)..

between the PA and Israel.[4] The Paris Protocol covered a range of economic sectors and established a mechanism for Palestinian-Israeli economic and financial relations. The model established in the Protocol for Palestinian-Israeli trade is known as a "customs union," the main characteristic of which is the absence of economic borders between the two countries (Haj Khalil, 2009). As a result, the Palestinian economy is integrated in, and dependent on, the Israeli economy.

The reality of this dependence becomes very visible when looking at how exports and imports operate in theory and in practice. In terms of exports, the Protocol stipulates that Palestinians have the right to export their agricultural production to external markets *without restrictions*, on the basis of certificates of origin issued by the PA. However, Palestinian trade with other countries is handled through Israeli sea and air ports, or through border crossings between the PA, Jordan and Egypt, which are also controlled by Israel (ibid.). With respect to imports, the PA has all powers and responsibilities over imports, customs policy and procedures related to the goods on Lists A1, A2 (agricultural products) and B (industrial products) of the Paris Protocol. These lists specify the quantities of goods that Palestinians are able to import and determine the rates of customs and other import charges, the regulation of licensing requirements and procedures, and regulation of standard requirements.

In practice, however, Israeli authorities apply different procedures for imports to Israel and imports to the PA. In many cases, the difference favours Israeli importers who can clear their goods more quickly and cheaply (e.g. storage and handling) and receive support services (e.g. issuing of telecommunication import licenses). In addition, Israeli laws, regulations and procedures relating to import-export are available only in Hebrew. This practice results in higher transaction costs for the Palestinian importer (Office of the Quartet Representative, 2013). Furthermore, the Israeli government imposes restrictions on Palestinian goods being transported into or out of the occupied Palestinian territory, whereby in commercial crossings goods must be unloaded from the Palestinian vehicle, checked extensively, then re-loaded onto an Israeli vehicle on the other side (Oxfam, 2012). Such realities mean that Palestinian imports and exports can thus cost twice those of Israeli imports and exports: average export cost and time for Israel are $670 and 11 days, whereas for Palestine they are $1310 and 23 days (Palestinian Ministry of Economy and the Applied Research Institute Jerusalem, 2011; World Bank, 2013). Regarding imports, trading costs and time are $650 and 10 days for Israel and $1225 and 40 days for Palestine (ibid.).

Under the current circumstances, the structural difficulties to import products to Palestine from countries other than Israel have led Palestinian traders to buy products through Israeli importers. Both Palestinian and Israeli importers have a clear incentive not to specify Palestine as a final destination due to the stricter security and clearance procedures detailed above. Indeed, according to the Bank of Israel (2010) a significant share of the goods sold from Israel to Palestine are indirect imports, with 58% of the total Palestinian imports from Israel produced in a third country. This fictitious enormous weight of Israeli imports in the Palestinian economy has been defined as the "hidden distortion" of the Palestine trade structure (Taghdisi-Rad, 2011).

Aside from the significant difference in trading costs between Israel and Palestine affecting Palestinian exports worldwide, Taghdisi-Rad (ibid.) argues that the other agreements between Palestine and the rest of the world have hampered the competitiveness of Palestinian exports while encouraging further ties with Israel. For instance the EU's separate arrangements for products from the Palestinian territories dictate that all agricultural products from the Palestinian territories should be sold through Agrexco, the official Israeli market agency. Other authors have also highlighted "the delicate issue of statistics" (de Pascale, 1996, 3) referring to the fact that exports to the EU from Palestinian territory appear most of the time as Israeli (settlement) exports. In this context the centrality of the informal sector in the current Palestinian economy should not be overlooked. The informal sector's activities go beyond survival, and it is the result of the increasing restrictions of conducting formal economic activities in the Palestinian territories (Taghdisi-Rad, 2011).

2.4. Palestinian Dependence: Tying Together the Elements of the Oslo Agreement

The examination of these aspects of the Oslo Agreement shows the significant link between land access, mobility, water, agriculture and trade; all are equally important to the Palestinian economy, have cross-links and strategically reinforce each other. As the implementation of the Oslo Agreement on the ground has shown, Palestine is materially and politically dependent on the Israeli economy. Dependence, as defined by Selby (2011), is a state of affairs where a society is heavily constrained by, and requires the material support of other societies that are neither constrained nor dependent of the material support of the society in question. This section has shown that Palestinian dependence is produced first by the constriction of society - expressed by declining internal water production, land access and movement and internal and external trade - and second through the material support needed by the society that is the result of this threefold decline.

Fig. 1 visualises how contemporary Palestinian dependency is rooted in relations of dependency between water, trade and agriculture. On the one hand, Israel's domination over water allocation and agricultural land in Palestine, together with control over Palestinian trade relations, have undermined Palestine's agricultural production capacities. On the other hand, Israel's movement restrictions on people and goods within the Territories and to the outside world have stifled the trade of agricultural products. This means that Palestinians are mainly dependent on Israel for importing the agricultural products that for the aforementioned reasons – among many others – they are not able to produce.

The material dimension of these dependency relations between water, trade and agriculture can be examined through the analysis of the agricultural trade flows in terms of water. The next section examines how, using a political ecology approach, the concepts of virtual water and water footprint can be used critically, and presents the methodologies used to estimate virtual water flows of the Palestinian Territories in order to contextualise these flows.

3. The Political Ecology of Virtual Water

Political ecologists have shown how the management of water is not merely a technical question that can be addressed through scientific expertise. It is the social nature of water that is at stake involving human values, behaviour and political-economic organisation (Budds, 2009; Linton and Budds, 2014). Water is a biopolitical resource (Bakker, 2012), suggesting that there is a link between the constitution and consolidation of political and economic power, on the one hand, and the control of aquatic socionatures, on the other. This in turn, "implies a shift from regarding water as the object of social processes, to a nature that is both shaped by, and shapes, social relations, structures and subjectivities" (Linton and Budds, 2014, 170). Society shapes and is shaped by water, both materially and discursively, and water flows are embedded in all institutional and political processes that both coexist with them and affect them (Swyngedouw, 2009; Kaika, 2004).

Both VW and WF approaches shed light on the material dimension of water circulation and offer metrics for a deeper analysis of water production and consumption, and water trade flows. Nevertheless, Beltrán and Velázquez (2015) take issue with the proliferation of studies with the objective of quantifying VW and WF indicators without referring

[4] Since the 1967 war, Israel amended the laws governing all aspects of trade and economic activity in place prior to its takeover. The way in which the Protocol was incorporated into Israeli Law is described in detail in Office of the Quartet Representative (2013). After this 'temporary' (five-year) framework expired, it was expected that the Palestinian government would have a permanent status upon obtaining Palestinian political and economic independence. The failure of the permanent status situation led to the extension of the Protocol of Economic Relations well beyond its intended lifespan (ibid.).

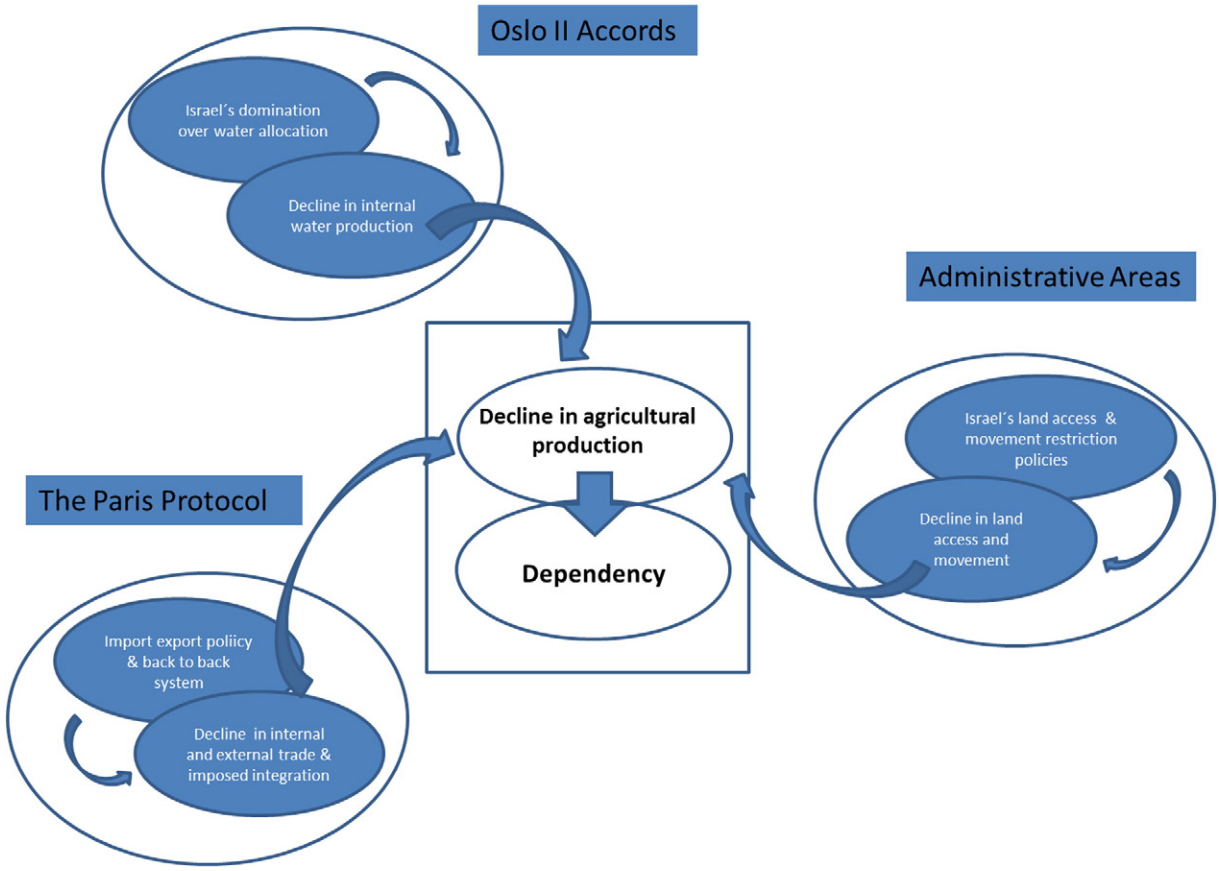

Fig. 1. Palestinian dependence: tying together the elements of the Oslo Agreement.
Source: own elaboration.

to the power relations associated with the circulation of these physical flows. Numerous critiques of VW and WF have also been launched both at the methodological and normative levels, largely pointing to the contradictions generated by these indicators when it comes to providing relevant information for the implementation of water and trade policies (Ridoutt and Pfister, 2010; Vanham and Bidoglio, 2013; Velázquez et al., 2011; Merret, 2003; Kumar and Singh, 2005; Wichelns, 2011, 2015; Gawel and Bernsen, 2013; Chenoweth et al., 2014). Wichelns (2010: 649) argues that 'virtual water and water footprint calculations are essentially silent on the most important aspects of water allocation and use'. Barnes (2013) shows that virtual water models abstract water from the material context of its use, while Gialis and Mavroudeas (2014) stress the social dimensions of economic relations that virtual water neglects, thus failing to assess how issues of labour, power and unequal exchange affect water resources.

From a political ecology perspective, Beltrán and Velázquez (2015) have shown that the VW metaphor, disembedded from its institutional and political processes, is distorting how we understand socio-ecosystems, shifting us from complex systems thinking toward simple flow analysis. In this vein, contemporary political ecology literature offers the theoretical basis to move beyond the techno-managerial analysis of VW flows, pointing out the importance of examining the material and socio-physical metabolic relationship embedded in the particular power relations associated with the circulation of physical flows (Bakker and Bridge, 2006; Swyngedouw, 1996, 2006). This combined approach of the political ecology of VW therefore goes beyond the estimation of water flows and illuminates that methodological efforts should be complemented by the consideration of the political, social and territorial drivers and implications of VW flows.

3.1. VW Flows From a Political Ecology Perspective

The studies undertaken to date on WF and VW in Palestine (Hamdi, 2014; Nassar, 2007; Nazer et al., 2008) do not present VW estimations within the wider institutional and political framework in which Palestine is immersed. In order to move beyond the critiques to VW and WF approaches, we mobilise quantitative and qualitative data analysis to show that VW flows are not just the flow of a resource, but the manifestation of the political and social relations that are organised around trade in the Palestinian Territories. This approach enables us to shed light on the power relations at the origin of VW flows and to question who controls the flow of VW and how; and whether VW flows, flow or do not flow, and why.

The methodology we use to estimate VW flows is the one developed by Hoekstra and Hung (2002) which proposes the estimation of the VW flows through the analysis of international trade, multiplying commercial flows by their water content. This is the so-called "top–down" approach, and it is most widely used to estimate VW flows.

This methodology is based on the concept of specific water demand (SWD). According to this method, the amount of water used to produce a specific crop depends on climatic parameters, on the type of soil and on the type of crop. These parameters allow to estimate each crop's water requirement (CWR_i), expressed in cubic metres per hectare. Given a yield for each crop (R_i), expressed in tonnes per hectare, its specific water demand (SWD_i) was estimated, expressed in cubic metres per tonne produced. One can estimate the virtual water that was imported or exported by multiplying the SWD by the data on international trade (X_i), expressed in tonnes. This is illustrated in the following

equations:

$$SWD_i = \frac{CWR_i}{R_i}$$

$$VWX_i = X_i SWD_i$$

To estimate the agricultural VW flows of Palestinian territories since the signature of Oslo Agreements we took data on agricultural production and crop yield from the FAOSTAT database[5] from 1997 to 2013. Crops included in the calculations were the main crops produced in the Palestinian Territories by area and production analysing the Palestinian Central Bureau of Statistics (PCBS) agricultural production database (PCBS, 2009a): tomato, potato, cucumber, eggplant, wheat, citrus (oranges and lemon) banana, olives (exported as olive oil) and dates. Crop water requirements were estimated using CROPWAT.[6] Import and export data production of the selected crops was taken from the FAOSTAT database from 1997 to 2013.

Since the purpose is to estimate the evolution of VW *agricultural* flows, we focus on the volume of water (blue and green[7]) used in agriculture (internal agricultural water use) compared to the volume of water imported and exported through agricultural products. Firstly we draw a temporal picture, estimating the agricultural VW flows of Palestinian territories since the signature of Oslo Agreements (1997–2013) using the data sources described in Appendix 1. Secondly we estimate the per capita agricultural VW imports and exports of the Palestinian Territories and compare them to adjacent countries (Israel, Jordan, Egypt).

To integrate these VW estimations with the wider Palestinian institutional and political framework, the analysis is based on information from different primary and secondary sources to corroborate findings and allow a process of triangulation. The first author conducted fieldwork over five months (in 2012 and 2013), with the support of the European Network of Political Ecology (ENTITLE) and Friends of the Earth Middle East. Quantitative and qualitative social research methodology consisted of anthropological direct observation, semi-structured interviews, surveys, and two focus groups with farmers in Auja (Jericho Governorate). Twelve relevant stakeholders representatives from different research institutes, NGOs and Palestinian government institutions were interviewed. She also administered a survey with twenty-one respondents and conducted two focus groups with farmers in the Auja Ecocenter (Friends of the Earth Middle East). Field notes were used to record her observations during the fieldwork period in a narrative, descriptive way. Finally, we systematically reviewed secondary data including policy documents, statistics and the reports of NGOs and international bodies.

We now turn to show how the flow of VW has been conditioned by the evolution of the political and social relations between Israel and Palestine during the Post-Oslo period, presenting the agricultural virtual water estimations in Palestine framed within the institutional and political context of the Post-Oslo Agreement.

4. How Do Virtual Water Flows Actually Flow? Results and Discussion

Fig. 2 shows the evolution of the VW agricultural flows of Palestine during Post-Oslo trade regime (1997–2013). It can be divided in three phases. The first is from 1997 to 2000, the years subsequent to the signing of the Oslo Agreement and before the outbreak of the Second Intifada. The second is from 2001 to 2009, where the impact of the Second Intifada from 2001 to 2005 is clear and then from 2006 to 2009 when Palestinian-Israeli relations become more stable. The third phase is from 2010 to 2013, when a significant shortage of rain affected the area. Overall the figure captures the effects of the Oslo agreement on trade, evident in the remarkable increase in VW imports. During the Second Intifada Palestinian VW exports and imports declined. The end of the Second Intifada meant a gradually recovery in trade and VW imports. From 2009 to 2010, both internal water use and VW imports decline, suggesting that perhaps they were affected by the same effect, possibly the prolonged absence of rainfall. Overall, during the analysed period Israel has been Palestine's main VW trade partner (US Agency for International Development [USAID], 2002; Paltrade, 2014) with the exception of the Second Intifada years, in which the trade relations between Israel and Palestine declined significantly (Observatory of Economic Complexity [OEC], 2015).

Prior to the Oslo Accords, the Israeli Administration controlled the affairs of the occupied Palestinian territory through direct military rule (UNCTAD, 2012a). Following the Oslo Accords, the first phase of Fig. 2, this was institutionalised under the terms of the Paris Protocol. After the signature of Oslo Agreement in 1993, up to 1999 we can observe a significant increase in trade activities between Israel and the Palestinian Territories reflected in the increase of agricultural VW imports (Table 1, and Fig. 2).

Agricultural VW exports did not experience substantial growth, despite the fluctuation in the value of exports, with an initial increase after the Oslo agreement (Fig. 2, and Table 1). This can be attributed to the Israel system of complex trade regulations and procedures and its impact on exports of time-sensitive goods, such as agricultural products (Djankov et al., 2010). Overall, the agricultural VW exports during the entire analysed period remained at an average of 3% of the agricultural water use. This might seem a low percentage but it is comparable to the export/import percentages computed for other Middle Eastern countries by Chapagain and Hoekstra (2004).

In this vein, the data shows that Palestinian exports of food products – and subsequently VW water – to Israel is insignificant in contrast to the Palestinian market for Israeli food products exports. From 1997 to 2008 both the internal agricultural water use and the total cultivated area in the Palestinian Territories remained fairly constant (PCBS, 2009b).

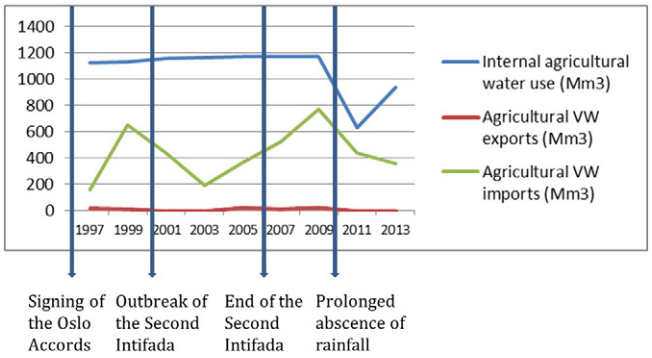

Fig. 2. The evolution of the VW agricultural flows of Palestine during Post-Oslo trade regime.
Source: own elaboration (based on FAOSTAT). Note: Internal agricultural use includes water withdrawals (blue water) which are in the order of 189 hm^3 (FAO, 2016), and soil water (green water), that is water received from rainfall and soil humidity.

[5] FAOSTAT is the data base of the statistic division of the Food and Agriculture Organization of the United Nations (FAO) (but see: http://faostat.fao.org/).

[6] CROPWAT is a free software for the calculation of crop water requirements and irrigation requirements based on soil, climate and crop data (but see: http://www.fao.org/nr/water/infores_databases_cropwat.html.

[7] Associated to the VW and to the WF concept, is Savenije's (1998) conceptualisation of water according to its origin: blue water and green water. Blue water is the water in rivers and aquifers, while green water is the water contained in the soil. Hoekstra and Hung (2002) first applied these concepts to VW and WF, and other studies soon followed (Chapagain et al., 2006; Aldaya et al., 2010). To this colour differentiation of water, grey water was added to designate polluted residual water derived from production and consumption processes (Hoekstra and Chapagain, 2008).

Table 1
Evolution of external trade in Palestinian Territories during Post-Oslo trade regime. Source: UNCTAD (2012b).

Year	Exports of goods and services ($ mil.)	Imports of goods and services ($ mil.)
1995	499	2176
1999	684	3353
2002	380	2519
2004	484	2909
2006	678	3202
2008	960	4086
2008	919	4363
2010	992	4962

Trade relations between Israel and Palestine declined significantly during the Second Intifada (2000–2005), coupled with a substantial drop in the value of exports from the Palestinian Territories (see Table 1). This decline was the result of severe border restrictions and the discriminatory treatment that Palestinian products received at Israeli ports (Taghdisi-Rad, 2011). This decrease in trade activities is reflected in the evolution of agricultural VW imports from 1999 to 2003 when we observe a decreasing trend in the evolution of agricultural VW imports until 2004 when they started gradually to grow again.

In the third phase, from 2009 to 2010 internal agricultural use dropped 50%. This significant decline is coupled with the fact that although from 1997 to 2008 the total cultivated area in the Territories remained fairly constant, the total cultivated area in Palestine decreased from 1,853,951 dunums (185,395 ha) (2007/2008 season) to 1,034,900 dunums (103,490 ha) in 2010/2011 season (PCBS and Palestinian Ministry of Agriculture, 2011). The reason for this decline is that following the shortfall in precipitation during several years, in 2009 the shortage of rain became a chronic event that compounded the water shortage situation in the Palestinian Territories (Food and Agriculture Organization of the United Nations [FAO] and OCHA, 2009) and resulted in the emergency decision of the European Commission to provide for €6 million for food assistance to victims of the water shortage in the occupied Palestinian territory[8] (European Commission Aid Office, 2009). The amount of rainfall in the West Bank for the rainy seasons during 2007–2011 was between 354 mm and 500 mm compared to the average annual rainfall of 532 mm (Palestinian Ministry of Agriculture, 2011), which constitutes only about 74% of the average annual rainfall in the West Bank. In the year 2010 decreasing annual rainfall forced Palestinian farmers to intensify their use of available water resources (Dweik, 2011). Of course, droughts are not just physical effects; they are also social and political. The fact that Palestine water use and agriculture for example were so vulnerable to natural water availability, has to do with the limited irrigation infrastructure and reservoirs governed by Palestine, which in turn has to do with its economic and geographical isolation, and the control of regional infrastructures by Israel.

The noteworthy decline in internal agricultural water use during this third phase was initially compensated by VW imports (see Fig. 1). Indeed, in 2010 the agricultural VW imports represented 90% of the internal agricultural water use, its maximum figure during the post-Oslo regime. Contrary to what could have been expected, from 2010 onwards the VW imports have continued to fall until 2013, the final year of data analysis (FAOSTAT, 2016). This reduction in VW imports is related to a reduction in grain imports,[9] a reduction for which we don't have a clear explanation. We suggest that it might be an accounting problem,[10] or that perhaps international food aid received in Palestine during the drought years (which is not accounted under trade, and hence not counted as VW), reduced food imports from Israel.

In short, the results show that both the political and environmental conditions have affected the volume of the VW flows as well as the origin/destination of products. Furthermore the results suggest that Israeli control over agricultural VW trade keeps these flows at a very low level during the analysed period, and not only exports, but imports too, relatively speaking. Table 2 compares the per capita VW agricultural flows of Palestinian and neighbouring countries' imports and exports. The per capita imported agricultural VW flow of Palestine is almost half of Egypt's per capita imported agricultural VW and only 15% and 11% of Israel's and Jordan's respectively. The final column of Table 2 shows that the per capita VW exported from Palestine represents 1.43% of internal agricultural water use while the same figure is 12.72%, 4.81% and 3.37% of the internal agricultural water use in Israel, Jordan and Egypt respectively. In short, this data reveals that Palestine's per capita VW agricultural flows on imports and exports are significantly lower than those of neighbouring countries. It is not only water to which Palestine has limited access to, but also virtual water.

In summary, the contextualised analysis of the evolution of agricultural virtual water flows offers two key results. First, virtual water flows have not remained constant over time but have been profoundly affected by the political and social relations between Palestine and Israel. Environmental conditions also play a role, affecting the Palestinian agricultural sector that is already vulnerable and counts on limited water resources. The case of the 2009 shortage of rain illustrated Palestinian reliance on virtual water imports from Israel. Second, the controversial application of the Oslo Agreement has resulted in Israeli control over Palestinian trade and hence over virtual water flows, especially in agricultural products. The imposed trade integration between Israel and Palestine implies that Israel has remained the main virtual water trade partner for Palestine in the post Oslo years, and that its position has been reinforced. The fact that from 1993 to 1999 an average of 80% of agricultural Palestinian imports came from Israel (US Agency for International Development [USAID], 2002) confirms that from the signing of Oslo Accords to the beginning of Second Intifada (2000) Israel was Palestine's main VW trade.

During the Second Intifada, the main importers were Jordan, Egypt and Europe, while Jordan and Europe were the principal exporters (OEC, 2015). From 2007 onwards, as the Second Intifada finished and trade relations were re-established between the Palestinian Territories and Israel, an average of 80% of agricultural Palestinian imports came from Israel (ibid.). The evolution of the agricultural VW flows shows that the outbreak of the Second Intifada forced a shift in Palestine's main VW trade partner. The end of the Second Intifada led to the return Palestine's main agricultural VW trade partner: Israel.

These findings provide quantitative backing to Selby's (2011, 6) claim that "Palestinian reliance on virtual water imports also involves dependency – not only upon Israel, but also upon global agricultural markets". Due to the hidden distortion of the Palestinian trade structure, it is difficult to know to what extent Palestinian reliance on VW imports involves dependency on Israel. As diverse studies suggest (Bank of Israel, 2010; de Pascale, 1996; Taghdisi-Rad, 2011), official trade statistics might not be reliable. Thus it is more than likely that Palestinian reliance on agricultural VW is based on indirect imports from countries other than Israel. Although examining the reliance of the trade statistics goes beyond the purpose of this paper, they key question here is how this "unreliability" is produced.

[8] The analysed period includes several years with low rainfall (1999, 2001, 2004; see: Gilmont, 2014). However the only year in the entire analysed period that the shortage of rain is coupled with a significant decline in both the internal agricultural water use and the total cultivated area in Palestine is 2010. In fact Gilmont (2014, 79) suggests for Israel that "by 2009–10, natural water supply had been reduced to the levels of the early 1960s". This reduction in natural water supplied in the region has probably affected this decline.

[9] Given that cereals, which accounted for 80% of Palestinian imports, are very intense in VW per production unit (Allan, 2010).

[10] The decrease in grain imports might be a data artefact given that the source of import data (FAOSTAT) from 2010 classified the data as an unofficial figure or FAO estimate. That means that in the absence of reliable sources or when information for the latest year is not available in time, figures for quantities and values are estimated on the basis of trade returns of trading partners.

Table 2
The per capita VW agricultural flows of Palestinian and neighbouring countries' imports and exports (1997–2001).

Country	Population	Internal agricultural water use (m3/capita/year)	VW imported (m3/capita/year)	VW exported (m3/capita/year)	% VW exported of the internal agricultural water use
Palestinian territories	2,961,737	386	108	5.52	1.43%
Israel	6,166,040	264	694	32.4	12.72%
Jordan	4,813,708	301	908	14.5	4.81%
Egypt	63,375,735	722	197	24.4	3.7%

Source: own elaboration, compiled from the figures of the Palestinian Territories estimated in this study and Chapagain and Hoekstra (2004). Note: data on the population of the Palestinian territories was taken from (PCBS, 2016). For the sake of the comparison, since the figures of Israel, Jordan and Egypt are taken from Chapagain and Hoekstra (2004) for the period 1997–2001, the figures of the Palestinian Territories have been estimated for the same period.

The analysis of the Oslo Agreement has shown that the both fictitious and enormous weight of Israel imports in the Palestinian economy is the result of the Israeli trade restriction policies, revealing that there is an interest in halting the flow of agricultural virtual water exports and in diverting the flow of agricultural virtual water imports toward Israel. Paradoxically, the Oslo Accord was defined as the "peace of markets", based on the idea that other aspects of the conflict (Palestinian refugees, the situation of Jerusalem or the settlements) would fall into place (Klein, 2007). Other voices were more sceptical, claiming that "when there will finally be peace between us (the Israelis) and the Palestinians, there will be a situation of dependence, of a structured lack of equality between the two entities" (Davidi, 2000, 38 cited in Klein, 2007, 430). As this analysis has shown, the high dependency on trade with Israel reveals a continuation of the "imposed integration" strategy that characterised the post-1967 economic regime (Arnon and Bamya, 2015).

In this sense, the agricultural VW flows shed light on the biophysical aspect of the political economy of non-conventional water resources that, together with the political economy of local natural surface and groundwater resources and the political economy of capital, technology and expertise relating to water, are the basis of what Selby (2011) refers to as Palestinian water dependency on Israel.

Ultimately the contextualised analysis of the agricultural VW flows in Palestine reveals that Palestinian dependence on VW imports is sustained by and organised through a combination of social processes on the one hand and metabolic-ecological processes on the other. The different aspects of the institutional framework of the Oslo Accords that were examined – the administrative areas, the Oslo II Accords and the Paris Protocol – are embedded within the unequal power relations between Israel and Palestine that constitute critical institutional and political processes. The environmental conditions, such as the average annual rainfall in Palestine, also play a key role to understand the complex processes that structure the water-agriculture-trade relationship that agricultural VW flows helps to illuminate. Only by considering the two dimensions together can we begin to understand the socio-natural relations that underpin and create flows, or nonflows of virtual water in Palestine.

5. Conclusion

Three findings and contributions of this study need to be highlighted.

First, The political ecology of water in the Middle East has been extensively studied, revealing how power over the territory goes hand in

hand with power over – and control – of the flows of water. This article complemented such studies with an empirical documentation, historically contextualised, that shows that it is not only water flows and access to water that is being controlled, but also trade and access to virtual water.

Second, the innovativeness of this article relies on showing in virtual water terms the inequality and instability of trade relations between Israel and Palestine because of an unstable political situation and the crucial role of the institutional framework set up by the Oslo Agreement in the socioeconomic and political relations between these two countries. The virtual water estimations, when contextualised, add complexity to this analysis, revealing the interlinkages between social and metabolic-ecological processes. We argue that this inherent complexity enables us advancing in the understanding of the VW flows as a metaphor that allows shifting from simple flow analysis toward complex systems thinking.

Third, ever since Allan's pioneering work, the concept of virtual water has been used as an optimistic antidote to apocalyptic concerns for future water scarcity, especially in regions such as the Middle East. Allan argued that countries can, and already do, adapt through trade to scarcity, importing 'virtually' the water that they cannot get locally. This is not however the end of the story. As our article shows, there is nothing natural about trade and the flows of water through it. Like water itself, virtual water through trade, is also governed by relations of power. And such relations can determine access to virtual water as they determine access to freshwater, making less powerful countries or parties more vulnerable to water scarcity.

A contextualised and politicised VW approach can shed light on the complex relationship between water, agriculture and trade in Palestine. A great deal of effort has been put into developing and implementing methodologies capable of estimating VW flows, but little attention has been paid to the contextualisation of virtual water estimations. Political ecology scholars have pointed out that the politicised nature of water management make it impossible to "abstract water from the social context that gives it meaning and from the socio-political processes that shape its material flows and its discursive representations" (Budds et al., 2014, 167). This paper shows the relevance of combining biophysical analyses - in this case agricultural VW flows - with the examination of the power relations that both coexist with and affect these flows. Bakker (2012) argues that there is a link between the constitution and consolidation of political and economic power and the control of socio natures. Following this idea, we argue that relating VW estimations to the wider institutional and political framework in which Palestine is immersed illuminates the link between the control of VW flows and the consolidation of Israeli political and economic power over Palestine. To continue to move beyond techno-managerial VW analysis, future VW studies can benefit from a political ecology of VW analysis in order to stress the social dimensions of economic relations that the VW approach so far has neglected, thus failing to assess how issues of labour, power and unequal exchange affect water resources (Gialis and Mavroudeas, 2014).

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