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Common Water Resources in the Occupied Palestinian Territories: Conflict and Co-operative Solutions

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Abstract

The UN recognizes access to water as a human right. The principle of "progressive realization" recognizes that available resources constrain access. We analyse water as a common resource. We show that an Ostrom common property regime can accelerate progressive realization. We examine the depletion rate and allocation shares in the common water resources of Israel and the Occupied Palestinian Territories. We design a hybrid "common property regime" that can harvest water efficiently and allocate it impartially. We outline a complementary compensation regime and distinguish three forms of Pareto efficiency to provide an attractive classification of the distributional outcome achieved.

Keywords: Water, human right, common resource problem, Israel and the Occupied Palestinian Territories, Pareto efficiency and distribution.

INTRODUCTION

"Access to safe water is a fundamental human need and, therefore, a basic human right" (Annan 2001).

The essential status of water is refelected in the UN International Covenant of Economic, Social and Cultural Rights (1966), ratified by 160 countries. Article 12.1 expresses the right of everyone to enjoy the highest attainable standard of health[i]. The Economic and Social Council (UN 2002) interprets this to include a right to safe water and adequate sanitation and it details the scope of the right. Anand (2007) and Biswas et al., (2008) discuss the status, expression and realization of water entitlements in developing countries and in the Middle East, respectively.

Target 10 of UN Millennium Development Goal 7 is to halve by 2015 the proportion of people that lacked access to safe drinking water and sanitation in 1990: it also reflects the essential status of water. UN Secretary General Annan (2005) provides the underlying rationale, "Water is essential for life…Water is crucial for sustainable development, including the preservation of our natural environment and the alleviation of poverty and hunger." The Millennium Development Goals Report 2010 reviews progress and concludes that the world is, "…on track to meet the drinking water target" (p.58) but acknowledges that this will still leave 14% of developing region population without access. It also notes "…the 2015 [sanitation] target appears to be out of reach" (p.60): 2.6 billion people lacked sanitation in 2008 and the report projects this will grow to 2.7 billion by 2015.

We believe that widening the rights-based conceptual framework to include a complementary economic dimension improves our understanding of water problems and our chances of meeting agreed water targets, for these reasons: First, Anand's (2007a) detailed empirical analysis of water rights and access concludes, "…while little improvement was noticed in some countries with a right to water, there were other countries where significant increase in the proportion of population with access to water was made without a formal right to water" (p.534). The implication is that declaring a right to water is not sufficient to secure its realization: an encompassing analytical framework that identifies impediments and promotes effective policy formation is also required. Second, the UN (2002, para1) describes water as a

"public good" and the World Health Organisation (WHO 2003) adopts this definition. A public good has the defining characteristics that (i) no-one can be excluded from consuming it and (ii) one person's consumption doesn't lessen its availability to anyone else. Even if we interpret the Covenant generously as making water *economically* non-excludable it is still clearly rivalrous: each person's consumption diminishes its availability to others. Water is a "common resource", not a "public good." The distinction is important. Governments supply public goods but common resources also require social institutions to successfully ensure a sufficient sustainable supply and - unlike public goods - to govern access to them. Ostrom (1990, 1997 and 2009) advances an economic framework of analysis, specifically tailored for common pool resource problems. We show later that it provides a clearer perspective than viewing them through a "public goods" glass darkly. Third, water crosses national boundaries. International experiences in sharing water resources vary with outcomes ranging from benign to catastrophic. Some regions have evolved "custom and practice" social institutions that enable them to sustainably manage and share water resources (for example, Saudi Arabia, Bahrain and Qatar, the United Arab Emirates and Jordan on the Arabian Peninsula). Other regions devise international legal instruments that specify the rules they will jointly use to manage their border-zone water resources, to protect against pollution and drought and provide dispute resolution. An example is the landmark Bellagio Draft Treaty between the US and Mexico. See Hayton and Utton (1989) for a discussion of this treaty and the legal issues surrounding international groundwater aquifers. In other regions rivalrous consumption entices citizens and governments to exert perceived "water rights" unsustainably at the expense of neighbours. Lake Chad, bordering Chad, Niger, Nigeria and Cameroon, was once one of Africa's largest lakes: the Aral Sea, bordering Kazakhstan and Uzbekistan, was once one of the world's largest lakes. Both have shrunk to under 10% of their original size over the last 40 years[ii]. Our analysis helps identify the sources of stress on water resources and provides insights into why some regions manage those stresses sustainably while others do not.

Section 2 of our paper overviews the reasons why "common resources" tend to get destructively over utilized. It explains why privatizing "common resources" and relying on markets or the state to provide them offer only partial remedies to the key concerns of efficiency and equity, especially where common resources are shared internationally. We identify key properties of "common property regime" institutions and governance that promote efficient, equitable and sustainable management of common pool resources.

The remainder of our paper then focuses on the shared water resources of Israel and the Occupied Palestinian Territories (OPT). Section 3 provides a précis of their complex water arrangements, contested claims, the interim distribution of water rights and the impacts it has on health and development. The two key players are at different stages of development and political and ideological patterns prevent them from evolving a common property regime to manage their increasingly stressed water resources and solve their increasingly acute joint water problems. See Rouyer (1997), Haddad (1998), Obidallah (2008), the Palestinian Hydrology Group (2008), the Water Authority (State of Israel) (2009) and World Bank (2009) for accounts of these difficulties.

We propose a synthetic "common property regime" for allocating water between the parties in Section 4. We demonstrate the improved mutual gains in efficiency and equity it confers on both parties vis-à-vis existing water arrangements. Much of the institutional architecture required to successfully operate such a regime is already in place. We identify and highlight the remaining obstacles that need to be overcome. Section 5 concludes.

2. PROPERTY RIGHTS, EFFICIENCY AND EQUITY

Hardin's (1968) "commons" is populated by self-interested rational agents who exercise their rights of access to its resources. This creates rivalries between the competing users and uses of those resources. Viewed benignly, these agents play a zero-sum game. [iii]

However, agents who harvest the natural resource output flow prematurely acquire a "first mover" advantage. Agents also have incentives to shirk resource maintenance costs. Each, expecting the other to act selfishly, seeks the "first-mover" advantage. Competitive rivalry leads them to prematurely and destructively overexploit the resource, the market fails and "…*freedom in a commons brings ruin to all"* (Hardin p.1244). In the language of game theory the agents play a non-cooperative positive sum game that invariably results in a Pareto suboptimal outcome. The 'tragedy of the commons' is that this rivalry depletes common resource output and - unless it naturally self-replenishes - may deplete the resource itself.

One remedy, favoured by Coase (1960), is to close the "commons" by privatizing the property rights to its resources. He claims that a well-defined system of private property rights promotes efficient outcomes by eliminating "commons" external costs and efficiency losses. It achieves this by giving the rights holders all the benefits and costs from owning the resources, exclusively; it entitles them to transfer or exchange their property rights as they please and it protects them by tort from conversion and encroachment by others. Non-rights holders buy or lease rights of access and use of the resources they need from rights holders. "Users who were receiving low marginal net benefits from their current allocations would trade their rights with those who would receive higher net benefits" (Tietenberg, p.189). A well-structured system of property rights and free trade, thereby, enable private owners to secure a social optimum. The traded prices of private resource rights depend only of the willingness of the negotiating parties to buy and sell: public intervention is neither necessary nor desirable – apart from undertaking the initial privatization and allocation of property rights and providing a supporting legal framework.

Coase (1960, Section IV) also claims that *any* initial allocation of private property rights will achieve an efficient outcome; the institution of private property ensures the market is efficient and it produces the largest possible economic surplus, provided the market for the newly privatized good is informed, rational, competitive and free of externalities.

Privatizing or repartitioning property rights does, of course, change the *distribution* of costs and benefits among the affected parties and it, therefore, impacts equity. The implication here is that the problem of finding an equitable distribution of rights is separable from the problem of finding an efficient distribution of rights. This would appear to offer those who are privatizing the rights all the flexibility they could require in devising an initial distribution of property rights that is consistent with societal norms of equity and entitlement. However, converting rights to common resources into unentailed private property *en passant* allows them to become detached and alienated from future generations. It changes their nature: it denies them the status of *inalienable* human rights. This is sufficient reason for many to reject the Coasian remedy of private property for the problem of common resources.

Coase recognizes that privatizing common property only guarantees efficient outcomes if there are no transactions or negotiation costs or if they are so small that they can be ignored. Common water resources that are shared internationally generally make it more difficult to

agree an initial privatization of water rights. They complicate and increase negotiation costs, especially where water resources are stressed.

Thus, the self interest that tends to destroy common resources may, paradoxically, produce efficient outcomes if the common-resources are privatized but only if certain restrictive conditions are met and only if society is willing to risk alienating "rights" from citizens. The latter caveats may have motivated the UN and WHO in describing water as a "public good."

The complexity and costs of negotiating private rights to a common resource tend to increase with the number of parties sharing it. If they increase sufficiently the state may prefer to regulate or nationalize rather than privatise the resource. This, however, carries separate risks of efficiency losses due to rent-seeking, as illustrated by Barbier et al., (2005).

Misconceptualising a publicly regulated common resource as a "public good" dodges the issue of how individual access to the common resource will be controlled and monitored and it suppresses rather than resolves the issue of equity and rights.

The more recent work of Ostrom (1990) offers an attractive framework for resolving some of these difficulties. She distinguishes common-pool resources (CPRs) which *can* exclude potential beneficiaries, but at a high cost, from pure "commons", which cannot. Many societies have evolved social institutions with co-operative allocation and sharing rules that preserve CPRs sustainably and mitigate these high exclusion costs. These rules govern the amount, timing and the technology used to withdraw resource output: Ostrom calls them "common property regimes". Her extensive field research warrants her concluding that "common property regimes" generate ***larger*** net benefits than privatization: "It seems that who monitors a forest[iv] against over-use is more important to successful governance than who owns the forest" (Ostrom, 2009 Nobel lecture). She also claims that the co-operative arrangements devised by users – common property regimes - produce superior outcomes than public regulation of CPRs and provide a superior remedy for common resource problems than either privatization or public provision and regulation.

An Ostrom common property regimes doesn't prescribe that water be privatised and is consistent with the WHO (2003) view that "…access to sufficient safe water is a human right [and that] …water is a legal entitlement, rather than a commodity or service provided on a

charitable basis" (p.9). Recognising this right as qualified and contingent[v], WHO actively promotes the principle of progressive realization which, "…mandates the realization of human rights *within the constraints of available resources*" (op.cit. italics added). An Ostrom common property regime that enhances resource efficiency, *ipso facto*, accelerates the progressive realisation of rights to the resources it governs.

Common property regimes are evolved forms of organisation with systems and structures of governance that sucessfuly prevent the destructive overutilization of common pool resources by producing: (1) broad consensus on sustainable use levels, (2) agreed criteria for determining individual access to the common resource, (3) effective monitoring of use levels and (4) effective sanctions when established use levels are exceeded (see Ostrom 1990).
We later explore the possibility of designing and constructing a synthetic hybrid common property regime to have these effects.

3. CURRENT WATER ARRANGEMENTS IN ISRAEL AND THE OCCUPIED PALESTINIAN TERRITORIES

a. HISTORY

The Occupied Palestinian Territories are composed of two distinct geographical entities: the West Bank and the Gaza Strip separated by the State of Israel. Following the 1967 War, Israel took control of water resources and developed wells and a water supply network to serve settlements. Palestinian water rights in the West Bank and river Jordan were abrogated. In 1995, the Oslo II agreement contained provisions that recognized undefined Palestinian water rights and returned some West Bank water resources and services responsibility to the Palestinian Authority (PA).

b. CONTESTED CLAIMS

In this region of frequent droughts water is is seen an indispensable asset and also as a strategic political resource. Both parties try to ensure a reliable supply. In the words of former Israel prime minister, Moshe Sharett (1953): "*Water to us is life itself*." Both parties also have different conceptions of their property rights and entitlements. We review these briefly and then examine how the water market is organized and how water rights are distributed in Israel and the Occupied Palestinian Territories.

Israel has consistently rejected calls to increase the Palestinian allocation of shared water resources, such as the shared Mountain Aquifer, on the basis that Israel's "prior established use" establishes its entitlement, in perpetuity, to most of the aquifer's water for its own purposes[vi]. When the World Bank recommended a new management regime in April 2009 Israel's Water Authority responded: "*This water has been developed and used continuously in the past by Israel within the "Green Line" (well before 1967), whether by diversion of spring water or by drilling of wells. It is clear that Israel has a natural right over this water, which complies with international norms (maintaining existing utilization*)."[vii]

Israel also argued that the water was not being used efficiently by Arab riparians and was, therefore, surplus water. It claims appear to rest on prior established use and user-efficiency[viii] as the key criteria establishing property rights and attach little weight to equity or to other considerations. However, customary international law and riparian rights allow water transfers only if the water needs within the basin area are first met. We examine the evidence below on this issue. See Phillips et al., 2004 for a detailed account of the implications of applying customary law to the allocation of regional water resources in Israel and Palestine.

Palestinians claim absolute sovereignty over the common hydrologic resources within their territory. They claim that groundwater rights should be allocated in accordance with the replenishment area of all the aquifers that are located within the West Bank. If water rights were so allocated, Palestinians would be entitled to 80-90% of the water within the area. However, while this forms the basis of establishing international mineral resource rights and could, in principle, also be applied to water it is not formally recognized by the rules of customary law.

c. MARKET ORGANIZATION AND TARRIFF STRUCTURE

Israel uses three key principles in determining water claims[ix]. These are:(i) Water ownership is public: there is no private ownership of water resources; (ii) Owning land does not confer a right in a water resource on the land or under it or adjacent to it and (iii) Each person has a right to a water allocation for a recognized purpose.

Under Israeli law water is public property (i.e. a regulated common pool resource): it is not State property. The State mediates the public's ownership of water with the private right to use it through its central Water Authority. The Water Council with representatives drawn from government, consumers, suppliers and producers advises government on how best to exercise its "custodial function" over water resources. The Water Commissioner fixes the annual water allocations for agriculture, industry and domestic uses. Municipalities distribute the domestic-use allocation to end-users via a metered network and users pay a progressive price tariff but with allowance made for family size. Industrial uses and agricultural allocations are subject to quota. Agricultural quotas originated from historical usage patterns that became codified as allocation norms for different types of crop, land/soil quality etc. Agricultural allocations also differ as between planned (kibbutzim and moshavim) and non-planned communities (see Israel's Water Economy op. cit., for details). Agricultural quotas have been reduced since the end of the 1990s. Water tariffs for domestic use are higher than Industry and Agriculture water tariffs because (i) traditionally, the industrial and agricultural production sectors were regarded as high *preferential-use* categories and (ii) water allocations to agriculture are often of poorer quality water (e.g. waste water) and are less reliable.

The Water Commissioner also grants annual licenses to private individuals to produce and pump water privately, subject to conditions. However, Mekorot (Israel's National Water Company) supplies over 2/3rds of the water supply.

d. THE INTERIM DISTRIBUTION OF WATER RIGHTS

The coastal aquifer that runs under Israel and Gaza is Gaza's sole fresh water resource. The sustainable water yield of the segment underlying Gaza is 57 MCM (millions of cubic meters), around 15% of this shared aquifer's total yield (approx 360-420 MCM). Water extractions are typically higher than the sustainable recharge yield: the 2008 overdraft was around 100 MCM or 200%. Consequently, this aquifer's water level is declining; its water quality is deteriorating and is subject to increasing seawater intrusion. Only 5-10% of the aquifer segment underlying Gaza is drinkable and more than 90% of its 150 municipal wells have salt and nitrate levels above WHO standards making these waters unfit for human consumption. See Worldbank (2009) *West Bank and Gaza: Assessment of Restrictions on Palestinian Water Sector Development* for details.

The Oslo accords, signed in 1993, incorporate the principle of mutual recognition[x] and codify the repartition of rights to waters located in the West Bank. The operative legal reference is the Interim Agreement, signed September 28th 1995, especially article 40. It provides the legal basis for today's water allocations: it states Israel's intention to return water supply institutions and infrastructures to the Palestinian Authority; it also establishes a joint water committee (JWC). To date, it has left the thorny question of who owns the water rights in abeyance, to be addressed in the permanent status negotiations – an omission that, we later show, may be fortuitous.

Table.1 summarises the Article 40 water rights allocation and represents the current interim solution. The Article 40 allocation to the Palestinian Authority is 118 million cubic meters per year (MCM/Y) *from the three West Bank aquifers* (+78 for future needs). Adding in this 'future needs' allocation, gives the Palestinians a little less than 30% of the total allocated. Israel receives the remaining 483MCM/Y, or a little over 70% of the total allocated from this source.

Israel's population was around 7.2 million in 2009; Palestine and the Occupied Territories' population was around 4.3 million[xi]. Hence, the Mountain Aquifer ground water available to be allocated in 2009 under the Oslo Accords averaged around 154 lpcd (liters per person per day), when scaled against their combined populations. Israel's actual interim allocation was around 184 lpcd and OPT's was 125 lpcd. These aquifer allocation shares are sensitive to how they are calculated.[xii]

Table.1. Allocation of Water Resources of the Three Shared Aquifers under Article 40

Mountain Aquifer	Estimated Potential	Israel	Palestinians
Total	679MCM/Y	483MCM/Y	118 MCM/Y (+78 for future needs)
Of which;			
Western Aquifer	362MCM/Y	349MCM/Y	22MCM/Y
North East Aquifer	145MCM/Y	103MCM/Y	42MCM/Y
Eastern Aquifer	172MCM/Y	40MCM/Y	54MCM/Y (+78 for future needs)

Note: The Oslo Accords does not provide access by Palestinians to any Jordan River water resources Source: Oslo 2, Annex 3, Article 40, schedule 10, 'data concerning aquifers'.

These groundwater aquifer supplies are augmented by surface water and other non-conventional water sources; more so in Israel. For example, Israel receives about 870MCM/Y or 2/3rds of the surface water drawn from the river Jordan, whereas OPT receive no allocation from this source. Israel's river Jordan allocation is almost twice the amount of water it receives from the three shared West Bank aquifers under article 40.

Estimates differ on the total water supplies both parties receive. Israel's Water Authority (2009) calculates the overall 2006 allocation of what it calls "fresh natural water" as 179m^3 per capita per year for Israel and 100m^3 for the Palestinians. It estimates (p.15) Israel's 1967 consumption at 508 m^3 per capita and OPT's as 85.7m^3 and concludes that the water gap has narrowed considerably.

Phillips et al, (2004, Table 4, p.24) calculate the average yearly regional utilization between 1980 and 1990 as 2,570MCM/yr with Palestine receiving 271MCM or 11% and Israel receiving 2,299MCM or 89%.

More recently, the Worldbank 2009 notes, "Water withdrawals per capita for Palestinians in the West Bank are about one quarter of those available to Israelis, and have declined over the last decade" (p.v).

Amnesty (2009) concludes, "Palestinian consumption in the OPT is about 70 litres a day per person ...whereas Israeli daily per capita consumption, at about 300 litres, is about four times as much" (p4).

These estimates differ in detail but share a similar broad pattern of disparity. They serve to highlight the need for a consensus uniform basis for calculating water access and usage.

Looking forward technical innovation in desalinating seawater using water more efficiently, for example by recycling more waste water, will ease the looming regional water scarcity but may be insufficient to offset the increasing stress of population growth. The combined population of Israel and Palestine and the Occupied Territories is projected to increase by around 1.4m by 2015[xiii]. This will further strain the water resources available to sustain public health and economic development.

Academic opinion suggests that a **minimum** water ration of 15/20 lpcd is required for survival and to avoid epidemics. The 1998 Sphere project uses 15 lpcd: WHO and UNICEF (2000) set the standard at 20 lpcd from a source within 1km of the user's dwelling. Gleick (1996) advocates, what he terms a **basic** water public health standard of 55 lpcd. WHO and Falkenmark both recommend an **optimal** water supply standard of 100 lpcd. Aiga (2003) tested a standard of 60 lpcd but found that 140 lpcd was required to contain diarrhea in young children within acceptable bounds. Different countires apply different norms, usually on an *ad hoc* basis; India, for example, uses a norm of 135 lpcd but doesn't give a scientific basis for it.

The available evidence suggests both populations are drifting towards whichever standard or measure we adopt - with the OPT are in a more advanced and precarious position. The World Bank (2009 p.v and p.17) estimates that the availability and domestic use consumption of water in the West Bank is close to 50 lpcd and is as little as 20 lpcd for around one sixth of those living in its connected southern towns. These consumption rates place most West Bank communities well below accepted international standards. One consequence is that public health costs from waterborne diseases in children under age five are equivalent to 0.4% of GDP (World Bank, 2009, p21).

Water scarcity also restrains economic development. The UN (2003) believes that, "Competition for water between city and agriculture will be a major challenge in the forthcoming century" (p.7). Agricultural water scarcity will impact OPT more than Israel. Irrigated agriculture Agriculture accounts for 2.6% of Israel's GPD and 2% of Israel's employment, whereas it accounts for 5% of OPT GDP and 12% of OPT employment[xiv]. OPT uses around 45% of its water for agricultural irrigation, which leaves 54% or around 64lpcd (liters per capita per day)[xv] for domestic and industrial (1%) use.[xvi]

The World Bank 2009 (see Table 2) estimates that water restrictions in agriculture (and the effects of the Separation Barrier) could represent a loss of gross margin of $480 million annually to the Palestinian agriculture economy (around 10% of its GDP), and a loss of 110, 000 jobs.

Table.2. Opportunity Costs of Water Restrictions to Palestinian Agricultural Economy

	Loss of Gross Margin $m	Agricultural Jobs Foregone
Land Closures in the Jordan Valley	58.9	12,500
Loss of Land to Construction of Separation Barrier	7.9	1,850
Loss of Land Beyond Separation Barrier	2.4	530
Loss due to non-Development of Irrigated Agriculture	410.7	96,000
Total	**$479.9m**	**110,800**

Source: The World Bank. Report No. 47657 GZ. April 2009.Table 5.1. p27.

Agriculture is more important to OPT employment and GDP and represents a possible pathway to future economic growth but its per capita agriculture water budget is just around one fifth that of Israel. Irrigated agriculture has a low share in Israel's GDP its food supply has a strategic significance. This is evidenced by the World Bank (2009 p.26) observation that Israel's subsidies to its farmers result in them paying just 0.818 NIS/m^3 (i.e. New Israeli

Shekels per cubic meter of water), whereas Palestinian farmers often pay more than 10 NIS/m^3.

The disparity in the water allocations mirrors more widespread disparity in economic conditions and living standards. The World Bank (2009 p.4) records Israel's national income as almost eighteen times Palestinian GNI per capita; it classifies more than 40% of the Palestinian population as poor, 38% as food insecure with 16% not being able to afford the minimum caloric intake.

4. PROPERTY RIGHTS, EFFICIENCY AND EQUITY REVISITED

a. REVISITING THE EFFICIENCY ARGUMENT

Allocation systems are generally judged on the efficiency and equity of the outcomes they produce. Inefficiency is usually measured by deadweight loss and arises when (i) too much or too little water is used or when (ii) quotas are withheld from high marginal net benefit groups and granted to low marginal net benefit groups.[xvii]

We cannot invoke the Coase theorem to infer that the current Israeli-OPT water rights system is efficient because water rights in Israel are not private. Water rights are not transferrable or saleable between private parties – a key requisite for an efficient system of private property rights (see Griffen and Hsu, 1993). Tietenberg (2007) explains, "Diminished transferability in turn reduces the market pressure towards equalization of the marginal net benefits" (p169) and frustrates attaining a social optimum. The establishment of *preferential use* regimes in agriculture, industry and the domestic sector or within specified geographical areas also inhibits transferability and efficiency.

Anad 2007 observes that inefficiency also arises, ".... when one of the participants in an exchange of property rights is able to exercise an inordinate amount of power over the outcome." Israel's Water Council moderates the concentration of power in State hands when mediating the public's right and access to water. Nonetheless, power remains concentrated: the Water Commissioner sets the quotas; Ministers set the water tariffs and favored groups receive subsidized quotas. For example Just, Netanyahu and Horowitz (1999) claim that

Israel deliberately calibrated the threshold levels of its block pricing structure to lower average water prices in regions "…where settlement is a national goal" (p108).

Discriminatory price tariffs or quotas, be they usage or location based, capture consumer surplus from high marginal value users. Some gets transferred to producer surplus or to low marginal value users, by implicitly cross-subsidizing the tariff they pay, and some leaks away in inefficiency losses. The emerging consensus is that these efficiency losses are becoming increasingly unsustainable. For example, UN (2003) observes, "Now, as the gap between the availability of water resources and demands on these resources widens, such *ad hoc* approaches to water allocation, planning and management will no longer be sustainable" (p.7). It recommends (op.cit.) that "Weaknesses and inefficiencies in existing institutional and operational mechanisms for allocating and reallocating water between sectors should be studied carefully."

Israel and OPT recognize that the existing water system is inefficient and, with existing desalination technology and population growth, is unsustainable. The question naturally arising is whether it is possible to construct a synthetic common property regime that can produce better outcomes?

b. **FINDING BROAD CONSENSUS ON SUSTAINABLE USE LEVELS**

The first task is to agree the common pool resource water categories whose sustainable use levels require determination. These include natural surface and groundwater. It seems reasonable to exclude wastewater (i.e. treated recycled freshwater) and impounded stormwaters to avoid creating negative water-recycling incentives[xviii]and to exclude desalinated seawater so as to incentivize the technical progress that may provide a long-term solution.

Ground-water stocks dominate OPT water supplies and their sustainable harvest rate is their rechange rate. Israel's sustainable water usage is more complex to calculate as it also relies surface water flows that vary seasonally and secularly with climate conditions. Notwithstanding, subject to the usual estimation hazards, technical experts can achieve broad consensus on the overall sustainable quantum of fresh water. Even if it is imprecise an

estimate will still generate efficiency gains provided it is closer to the true sustainable rate than the current extraction rate.

c. FINDING AGREED CRITERIA FOR DETERMINING INDIVIDUAL ACCESS TO THE COMMON RESOURCE.

Israel's Water Law (5719-1959) expresses the principle "...that each person has the right to a water allocation for recognized purposes" (Ministry of Foreign Affairs, Israel 2002). It is consistent with the UN/WHO view that access to sufficient safe water is a human right, albeit that neither source quantifies the implied entitlement. It may help to conceptualise this minimum "sufficient safe" quantity as a "quasi" public good that; (i) no citizen can be legally excluded from enjoying and (ii) any citizen's consumption doesn't lessen the availability or entitlement of any other citizen to a "sufficient safe" allocation. This presupposes that the "sufficient safe" quantity for the entire population is less than the available water resources.

Water is an economic good: it "…*has an economic value in all its competing uses and should be recognized as an economic good*."[xix] Accordingly, the UN (2003,p vii) recognizes the need to price it efficienctly, "*Efficient sectoral water allocation cannot occur if prices fail to reflect the true costs of water provision and the scarcity value of water itself. Getting the price right at the subsectoral level is fundamental to achieving optimal water use not only within but also between sectors.*" This raises two questions;

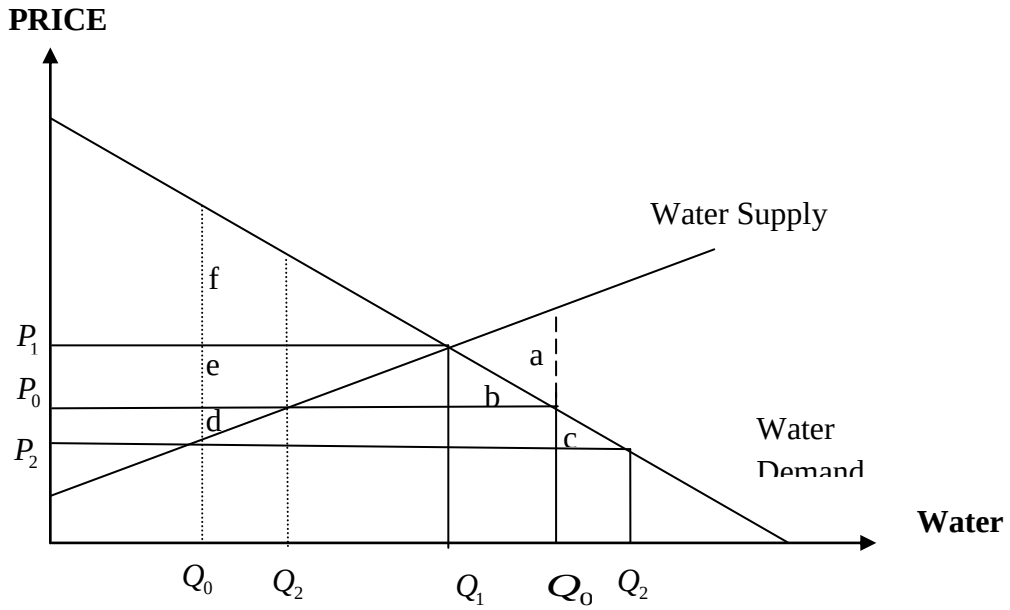
(i) Does the price mechanism offer an effective means of curtailing over-utilization?
(ii) Since pricing is a mechanism that excludes those who cannot pay, how can it be reconciled with the concept of entitlement by right?

Darr et al, (1975) estimate the price elasticity of household water in Israel is low, between .05 and .15; Fiselson (1993) estimates that it lies in the .18 to .60 range and Bar-Shiva et al. (2006) estimate the *long-run agricultural* water price elasticity as -.46. These low estimates appear to suggest that price has little impact on water demand and offers limited scope for restraining it. However, Bar-Shiva et al. found that switching from a single uniform water price to a block pricing structure yielded a 7% reduction in water usage *at the same average water price*. Tietenberg (2007, p.179) similarly recounts that, notwithstanding its growing population, water consumption in Zurich fell by 23% between 1970 and 1997, after it introduced an excess water charge for consumers whose consumption exceeded a specified

water threshold. We expect *a priori* water demand is inelastic in the neighbourhood of outright need but responds more elastically to price change the more water consumption exceeds the "sufficient safe" threshold[xx]. The Zurich-style block pricing structure reconciles the concept of entitlement by "right" to a "sufficient safe" quantity of water with the need to price scarce water resources sparingly and efficiently. The *average water price* and the *water pricing structure* are *both* important in achieving these objectives. The efficiency achieved promotes the progressive realization of resource-contingent rights and it facilitates a more generous definition of what consititues a "sufficient safe" quantity.

Diagram 1 is a simple stylized representation of the current system and the alternative we propose. Current water output is Q_0 and is priced at P_0. It exceeds the efficient rate of Q_1 and generates the "deadweight" loss triangle 'a'. Also, the water quota Q_0Q_2 is withheld from a high marginal value user cohort and is sold to a low marginal value user cohort at a concessionary price of P_2.

Diagram 1. Current and Proposed Water Output and Pricing Systems



We propose that the Water Authority switches to an efficient regime by reducing water output to Q_1 and selling it at the uniform price P_1. As output falls from Q_0 to Q_1, the affected users' consumer surplus falls by the triangle 'b' but the Water Authority makes a net saving of 'a' + 'b' so it can fully compensate all of these affected consumers with the deadweight loss saving 'a' to spare.

The favored preferential user cohort that formerly received the water quota Q_0Q_2 at the concessionary price P_2 now loses it, as the single market price rises to P_1. Their consumer surplus falls by the triangle 'c'. The Water Authority now sells Q_0Q_2 at price P_1 and increases its revenue by'd + e'. Hence, it can compensate the loss of consumer surplus 'c' with funds to spare. The new users who now buy this water also gain the additional wedge 'f' of consumer surplus.

The remaining consumers pay a higher price P_1 on the remaining (Q_1 - Q_0Q_2) units they buy. The extra revenue - $(P_1 - P_0)(Q_1 - Q_0Q_2)$ - that the Water Authority receives is exactly the amount it requires to fully compensate these consumers. Hence, the Water Authority has ample funds to compensate all losers and has a surplus left over. It could use some of that surplus to improve the technology, the distribution network or to enhance the structural adjustments users have to make. We focus here, however, on how rights can be protected and, later, on how the remaining surplus can used to incentivize mutual co-operation.

Governments wish to protect the rights of their citizens to a "sufficient safe" quantity. Assume for convenience, that Q_0 is the total "sufficient safe" quantity of all users. Hence P_1Q_0 is its economic value and is the amount of money the governments must transfer to the Water Authority to induce it to operate a block pricing structure under which the "sufficient safe" quantity is provided "free" to each citizen and any excess water usage is charged at the marginal cost price of P_1[xxi]. The key point is that an efficient regime can simultaneously protect the rights and entitlements of citizens and exploit the efficiency properties of marginal cost pricing.

d. EFFECTIVE MONITORING OF USE LEVELS.

Water consumed by users exceeds the amount distributed by the Water Authority due to (i) losses in the distribution network (ii) the drilling of unauthorised wells (iii) illegal water tapping of existing supplies.

Israel's Water Authority (2009 pp.9-10) claims that losses in Palestinian water networks, including illegal usage losses, are about 33%, compared to 11% in Israel's domestic networks. It claims that Palestinains drilled 250 illegal wells, mainly in the North-East aquifer, yielding 10MCM/yr and harvest a further 3.5MCM/yr from "pirate" connections to Mekorot's water pipelines. It also claims that OPT, paradoxically, has chosen for strategic reasons not to harvest an additional 40 MCM/yr in the Eastern Aquifer to which it is entitled.

The World Bank (2009 p.9) claims OPT per capita access to West Bank water resources is a quarter that of Israel and falling. It claims Palestinians abstract just 20% of the "estimated potential" West Bank water resources while Israel receives the balance. It claims Israel is overdrawing its agreed quantum by more than 50% and it acknowledges that some West Bank communities drill unlicensed wells to obtain drinking water.

Amnesty (2009, p.22) claims that, "*...restrictions imposed by the Israeli army have delayed or prevented the drilling of even those wells which has been approved by the Joint Water Committee (JWC). Similarly, Israel has consistently refused to allow Palestinians to locate sewage treatment facilities and solid waste dumps in Area C, the only areas where there is land available for such facilities.*" Israel is responsible for civil and security affairs in Area C, which makes up 60% of the land mass of the West Bank. Amnesty also claims (p.4) that, "*The army smashed the villagers' rainwater harvesting cisterns, some of them centuries old, with bulldozers and filled them with gravel and cement to prevent their repair*" in Susya and in adjoining Palestinian villages.

These claims and counterclaims hallmark the scarcity and uneasy division of shared water resources. Their heated contested nature suggests there is a need for an Independent Monitoring Committee to monitor *both* water production and water consumption levels and independently record actual water usage levels, variations from agreed levels and the reasons underlying them and is reinforced by the natural justice principle *nemo iudex in causa sua* – no-one should be a judge in their own cause.

Harvested rainwater, treated and recycled waste water and desalinated seawater are substitutes for agreed-use quotas of "fresh natural" water. Therefore, illegal restrictions or impediments that reduce them also reduce the total water supply available to the impacted

party. Consequently, all such restrictions and impediments, together with illegal water tapping and use of unauthorised wells, need to be monitored and made liable to sanction.

Information and communications technology (ICT) devices, such as smart meters, may domestic and commercial interests to monitor and manage water resources more efficiently.

e. EFFECTIVE SANCTIONS WHEN ESTABLISHED USE LEVELS ARE EXCEEDED.

Jakee and Turner (2002) argue that for a commons regime to be successful, "…*well-designed institutional structures must effectively limit the scope of opportunism by establishing a high degree of incentive compatibility between the narrow interests of individual actors and the broader interests of the collective*" (p.483). Table 3 depicts, in a stylised water game – Game 1, the opportunism and narrow interests the parties must overcome. Each payoff pair in the table is a measure of the water supply available to Israel and OPT, respectively, that depends on whether the parties co-operate or compete. Both parties are better off if they both co-operate and receive (120, 90) but each, believing their counterparty is motivated solely by self-interest, elects to compete. As a result they destructively over-utilize the resource and each party receives less (i.e.80, 40) than if had they co-operated. Yaqub (2009) terms a conflict strategy, "*When two or more parties, with perceived incompatible goals, tend to undermine each other's goal-seeking capability, they are experiencing conflict*" (p.21). The conflict solution yields an inferior payoff to both parties than co-operation but prevails due to lack of communication and mistrust. To overcome this, the parties need to mutually-agree credible sanctions for breeching agreed water use levels so that each gains more by co-operating, unconditionally, that is, irrespective of the strategy their counterparty adopts.

Table 3 Payoffs in a Stylised Water Game

	Game 1 (No Forfeit)		**Game 1 (With Forfeit = 25)***		**Game 2**	
Strategies	***OPT Co-operates***	***OPT Competes***	***OPT Co-operates***	***OPT Competes***	***OPT Co-operates***	***OPT Competes***
Israel Co-operates	120,90	70,110	120,90	95,85	120,90	90,110
Israel Competes	130,30	80,40	105,55	80,40	105,50	80,40

*The forfeit of 25 is paid by the non-cooperating party and received by the cooperating party.

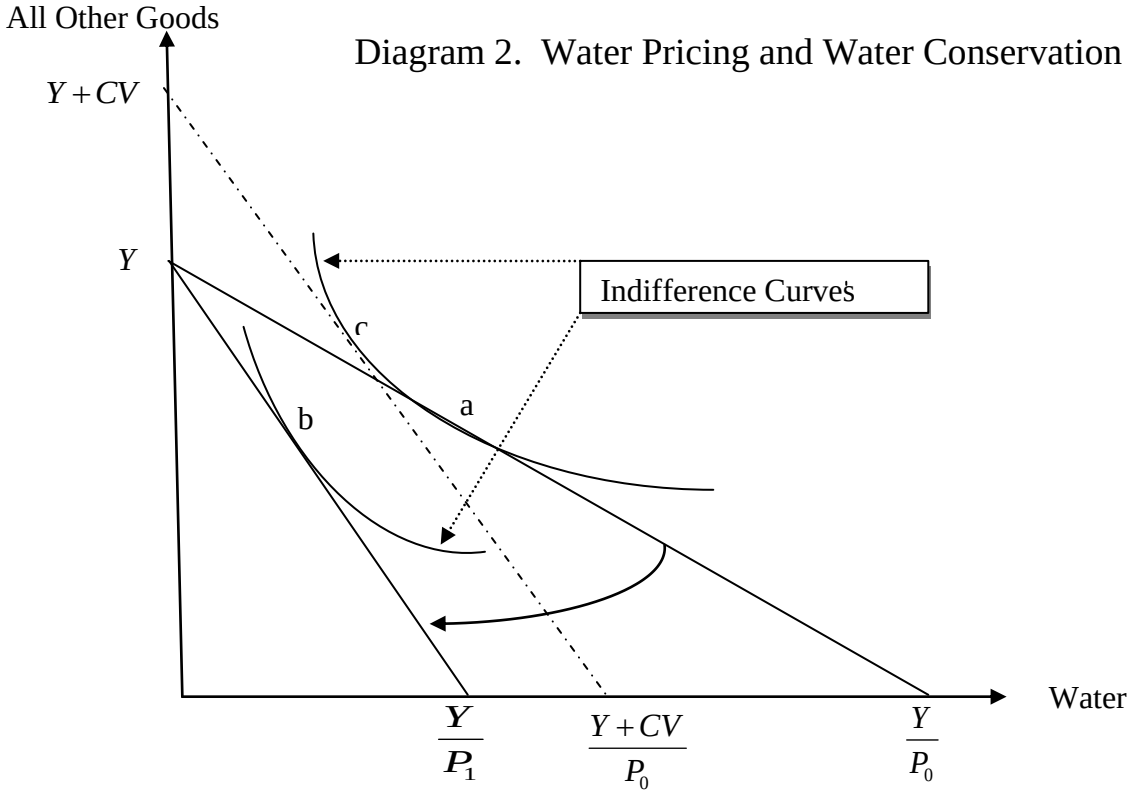
Table 3, Game 1 with forfeit, assumes that a mechanism has been developed that allows each party to credibly precommit to a forfeit of 25 for competing when their counterparty is co-operating. The resulting net-of-forfeit payoffs always yield an unambiguously larger payoff to each party from co-operating unconditionally, i.e. *irrespective of the strategy their counterparty adopts*. A wide set of forfeit penalties exists that by makes co-operation the dominant strategy and provides each party with a bigger payoff and quells the impulse to destructively over-utilize the common resource.

In settled conditions an Ostrom "common pool regime" may evolve efficient sharing rules *spontaneously* but such cooperation requires[xxii] high trust, presently lacking between Israel and OPT, between the counterparties. However, they have many of the building blocks are in place that may enable them to construct a "hybrid" or "synthetic" common property regime[xxiii] that would yield both a better and more equitable outcome. First, as water is publicly owned the focus shifts away from who owns it to who uses it.[xxiv]Second, Israel's law acknowledges each person's right – Israeli or Palestinian –to an allocation of water and establishes the important principle none shall be left without. Third, as Diagram 1 illustrates, a Joint Water Authority that is statutorily bound to maximize economic surplus and to sell the efficient supply[xxv] at a single non-discriminatory water price[xxvi] will make efficiency gains that *can* enhance the welfare of all parties. Fourth, a Joint Water Council with members

drawn from all affected parties – a parallel "synthetic" Ostrom-style cooperative arrangement – can devise compensation rules to guarantee that no affected party is disadvantaged and left worse off by the switch to an efficient system. It would estimate the parties *compensating variations* to guide its members in establishing the rules, mechanisms and amounts of compensation to be paid to claimants and would draw the necessary budget from the efficiency savings generated by switching to an efficient water regime.

Diagram 2 illustrates how these approximate guidance compensation amounts can be determined and funded. The water user's budget is Y, the price of water is P_0 and the price of all other goods is normalized to 1, for convenience and the water user positions at point a. A higher efficient water tariff of P_1 rotates the budget line inwards and the user repositions to point b. *If the user is given a compensating variation of CV she repositions to point c and is no worse off or better off than before the price rise*. The higher water price, however, conserves water usage. If this price increase only generated a *substitution effect* then point c would lie directly above point b but water as a normal good the *income effect* of the compensating variation CV the user receives will position point c a little to the right of b.

Diagram 2. Water Pricing and Water Conservation



We can estimate the size of the compensation variation that leaves each water user no worse off than before the price rise. Forrmally, $\varepsilon^* = \varepsilon + \theta\xi$, where ε^* and ε are the compensated and uncompensated price elasticities, respectively, θ is the budget share of water and ξ is the income elasticity of demand for water. The share of water θ in most users' budgets is small (typically well under 10%). Fiselson 1993 estimates the long term income elasticity ξ in Israel[xxvii] lies between .2 and .4, which is consistent with the Nauges and Whittington 2010 finding that "…income elasticity is typically in the range 0.1–0.3" in developing countries. Consequently $\theta\xi$ is very small (i.e. typically no more than .01 to .04) which implies that the compensated and uncompensated price elasticies are approximately the same i.e. $\varepsilon^* \approx \varepsilon$. This simplifies matters. It implies that the loss in a *consumer's surplus* ΔCS_i, following an increase in the water tariff, closely approximates the required *compensating variation,* CV_i or guidance compensation amount that person should receive. The Water Authority knows the quantity and price that users pay for water before and after the regime switch so it is well positioned to estimate the change in consumer surplus ΔCS_i. A simple linear approximation of user i's compensating variation CV_i and guidance compensation amount is $CV_i \approx \Delta CS_i \approx .5\Delta P_i \Delta Q_i$, where, ΔP_i is the price increase user i pays for water and ΔQ_i is their consequential reduction in their water usage.

We recognize that there are also important obstacles to overcome in establishing the well designed institutions that Jaker and Turner advocate. First, both parties must cede sufficient powers to the institution to make its penalties credible. This is a political issue. International community institutions may be able to assist the design of a suitable "escrow" process and nudge the required arrangements and institutions into existance.

Second, the total gain from joint co-operation may be estimable but, unlike the stylised water game in Table 3, how it gets divided between the two parties is unknown and has to be negotiated. A "hybrid" regime can improve efficiency and it satisfies the Kaldor-Hicks criterion: winners can *potentially* compensate losers. Since the gains and losses from implementing a "hybrid" system are likely to be substantial then, unless it also has a satisfactory *actual* compensation mechanism, the "hybrid" regime will likely prove politically infeasible and will entrench the inefficient status quo. A further complication arises. If each party is motivated solely by their own gain it is rational for them to accept *any*

Pareto improving division of the total gain from co-operation. However, Fehr and Schmidt (1999) show that if they are motivated by disadvantageous inequality aversion this will lead each party "...to sacrifice potential gain to block another individual from receiving a superior reward." This, Fehr and Schmidt argue, is not irrational. It 'keeps the process honest' by creating an environment that promotes stable cooperative bilateral bargaining. It may also help us to understand why inferior conflict outcomes persist: the greater is the cumulative sacrifice of gain that the parties invest in trying to secure the "credibility" of their conflict strategies and their resolve to stand over them indefinitely the more reluctant they are to abandon them. The Fehr and Schmidt perspective highlights the fact that the economic value of water doesn't inhere solely in the resource itself but is also the result of a stable negotiation process that produces the efficient rate of output, allocates it efficiently and equitably and minimizes the negotiation and transaction costs incurred in managing it.

Game 2 in Table 3 illustrates the Fehr and Schmidt result in a 2-party game setting. Both parties are initially not co-operating. Each party can increase their payoff by 10 by co-operating *even though their counterparty continues not to cooperate:* cooperation is unconditionally Pareto efficient. However, each party elects not to co-operate because to do so would confer a disproportionate gain on their counterparty. Disadvantageous inequality aversion is also observed in 2-person 'ultimatum' games in which the first player decides how a fixed payoff will be split between the two players and the second can accept or reject that split; in the latter case both players receive nothing. The stingier the payoff to the second player is the greater are the chances that the second player will reject it, despite having to sacrifice a positive payoff for a zero payoff by so doing (see Fehr and Schmidt p.826).

We agree with Ostom's conclusion that users acting co-operatively, say in a Joint Water Council, will tend to devise and settle arrangements amongst themselves that work better than state-imposed public regulation. We offer a novel equity standard to assist their deliberations and that provides a convenient categorization of inequality aversion. We will style the outcome achieved as;

1. *Weak-form Pareto Efficient:* if no party is made worse off and at least one party is made better off.

2. *Semi-strong form Pareto Efficient:* if no party is made worse off and the compensation narrows the income gap between the parties, ceteris paribus.

3. *Strong-form Pareto Efficient:* if no party is made worse off and compensation is targeted on the poorest in the income distribution.

These three forms of efficiency borrow the nomenclature but not the substance of Fama's (1970) categorization of efficiency in financial markets. Weak form efficiency is consistent with a widening income gap, albeit that all parties are absolutely better off. Semi-strong form efficiency is progressive and requires that the income gap be narrowed. Strong-form efficiency implies that all parties have minimum entitlements that must be provided first from any efficiency gains[xxviii] and is underpinned by a Rawlsian concept of equity or justice.

Third, Israel's Water Authority (2009) discusses the possibility of Israel ceding a greater allocation of West Bank aquifer water to OPT and desalinating additional water to make good its own losses. It concludes, "... assuming that the environmental impacts and the costs can be disregarded or ways found to overcome them, *we will still not solve the strategic problem of water security, with seawater desalination plants being vulnerable and their critical importance, due to the extent of their output*" (p24, italics added). This acknowledges the wider security issues that impact Israel's water strategy and negotiation stance. Those issues may entail target population changes and settlement patterns that push the permanent water allocations the parties seek beyond what is equitable or sustainable. Solving the water problem instead and first, as a joint exercise between the parties may increase co-operation, enhance credibility and ease the insecurity that entrenches the inferior conflict outcome.

f. **DISCUSSION.**

The UN (2003) proposed using thirteen hallmark criteria[xxix] for allocating water resources efficiently and equitably between competing users. But its criteria are general and as some compete with others it is unclear how they might be applied in practice or what institutional structures and arrangements are best suited to apply them.[xxx]

Transitioning from theory to practice also entails accommodating a host of additional complications such as water quality, reliability, seasonal factors, climatic factors, distribution costs, settlement rates and patterns and so on, that we have not addressed. The UN (2009) explores in detail the consequences of fleshing out an operational model of water allocation to accommodate some of these addiditional factors.

These contributions are helpful but, like the unsettled state of international water law, they are too broad to prescribe the size of the water harvest or how it must be divided or the terms on which it may be accessed. Our work complements these efforts by focusing on some of the key analytic and strategic problems that are encountered in constructing a "hybrid" common property regime whose institutions and governance are directly targeted at addressing the issues of quantum, allocation, right of access and terms of access.

CONCLUSION

Water is a common resource. Internationally shared water resources are vulnerable to destructive over-utilization. Some regions successfully transition from open access to common property regime governance, mitigate over-utilization and protect the rights of users. In other regions population growth and related factors stress the available water resources and political rivalries hinder successful transitions. Our analysis shows that successful transition generates economic efficiency gains sufficient to benefit and incentivise all the parties making the transition. 'Designing-in' the distribution of those gains into the political governance structures of a hybrid common property regime so that all parties are winners may be a key to its success.

The alternative Hardin "commons" is a "groundhog day" world in which agents are doomed to repeat the inferior outcomes they achieve in the positive sum games they play *ad infinitum* or until the resource drys up, eschewing the mutual gains that are available from cooperation.[xxxi] Conceptualising water as a public good diverts attention from identifying the optimal or economically efficient harvest to the process of finding the harvest that satisfies political preference: it also vetoes any consideration of how it gets distributed or the public's rights of access since these issues cannot arise in the case of pure public goods.

We focused on the joint water problems and current water arrangements of Israel and the Occupied Palestinian Territories. We identified some current arrangements and some (Oslo promoted) institutions that provide a basis and an opportunity to construct a "hybrid" common property regime: we also identified some remaining obstacles. The hallmark features of the "hybrid" regime that we blueprinted are the efficieny gains it confers on both parties and its capacity to protect their water rights and entitlements. Achieving a successful "hybrid" regime entails some issues of statecraft beyond the scope of our paper but we have,

at least, shown that it is both possible and desirable to advance the economic welfare of ***both*** parties.

The solution we offer also raises interesting political issues, such as the level of linkages the two sides want to develop in their overall relationship. The more tasks they tackle jointly and the wider their scope the greater becomes the degree of interdependency. Economic integration, even amongst former combatants - as the European Union project shows – can progress towards greater economic and political integration. But this presupposes voluntary cooperation as an alternative to the traditional postures that have resulted in conflict. The underlying question that arises is what type of relationship the two states want to develop. Contemporary history, cultural differences and unequal levels of economic development push them in opposite directions but their economic interdependency (especially on the Palestinian side) draws them together. Like many before them, Israelis and Palestinians may discover that have as much in common as what divides them.

We focused our study on Israel and OPT but we expect that the issues we raised and the solution we proposed may have wider application in other regions.

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[i] This echoes provisions in Article 25 of the UN Universal Declaration of Human Rights.
[ii] The shrinking of the Aral Sea provoked international tensions after the Soviet Union diverted, for irrigation projects, the rivers that fed it.
[iii] "The proposition of solving the problem of Palestinian water shortage by exacerbating Israel's water scarcity is utterly unacceptable" The Water Authority, State of Israel 2009. The Issue of Water between Israel and the Palestinians (p.30.). This sentence is an example of a zero-sum view of the water problem.
[iv] This inference clearly generalizes to other common-pool resource, such as water.
[v] Article 22 of the UN Universal Declaration of Human Rights similarly recognises that economic, social and cultural rights are qualified "in accordance with the organization and resources of each State"
[vi] "The Palestinians have never used this water. This fact grants Israel rights of possession and use regarding this water, even according to international law." (p.29)The Water Authority, State of Israel 2009. The Issue of Water between Israel and the Palestinians
[vii] The Water Authority, State of Israel. The Issue of Water between Israel and the Palestinians. (p.25). 2009.
[viii] They also fail to identify whether technical or economic efficiency should form the basis of allocation.

[ix] See Ministry of Foreign Affairs, Israel. 2002 for details)

[x] Both parties have adopted the principle of *mutual recognition* and acknowledge the necessity of taking into account the needs of the counterparty. Hence, "…*Israel recognizes the Palestinian water rights in the West Bank*"Annex 3, Appendix 1, Article 40, Oslo 11 Agreement.
[xi] 2009 UN population data issued on 31 Jan 2010, available at http://www.guardian.co.uk/world/datablog/2010/feb/01/united-nations-population-world-data
[xii] The CIA World Fact Book, until recently, gave the Israeli population as 7.35m (with 187,000 settlers living on the West Bank and 177,000 in East Jerusalem) and the Palestinian population as 4.1m (1.6m living in Gaza and 2.5m in the West Bank). If the 364,000 settlers in OPT are watered from the OPT water allocation then Israel's allocation increases to 180lpcd and the Palestinians' falls to 120lpcd. The Palestinian allocation drops further to 72lpcd, if, additionally, it doesn't take up its 78MCM/Y allocation for future needs. (It hasn'tfully done so to date)
[xiii] The OPT population is projected to increase by about 777,000 to 5.26m (see UN 2003, Table 3, p.8). Projecting Israeli's 2010 population of 7.35m (CIA World Factbook) at its 1.628% annual population growth rate (CIA World Factbook) implies that it will increase by around 620,000.
[xiv] Agriculture accounts for 2.6% of Israel's GPD and 2% of Israel's employment; it accounts for 5% of OPT GDP and 12% of OPT employment (CIA World Fact Book).
[xv] The Palestine Monitor Factsheet (http://www.palestinemonitor.org/spip/spip.php?article14 – Water (updated 18 Dec 2008)) gives 63lpcd in the West Bank and 140lpcd in Gaza in 2008 and notes that water quality is poor.
[xvi] See Water Commission (Israel) for a detailed breakdown of water usage.
[xvii] That is, withheld from groups positioned "high up" on the demand curve and allocated to those "low down" on it. Efficiency consequently worsens if the disfavored group illegally "taps" water or discharges untreated wastewater.
[xviii] Provided that off-site discharges don't create externalities that negatively impact others)

[xix] The Fourth Principle of the 1992 Dublin Statements, adopted at the International Conference on Water and the Environment (ICWE) in Dublin in January 1992, which gathered more than 500 participants, including government-designated experts and members from intergovernmental and nongovernmental organizations.
[xx] This inference is consistent with Stone-Geary utility in a Linear Expenditure System.
[xxi] Governments could, alternatively, transfer a "sufficient safe" budget directly to each citizen; this is an administrative matter.

[xxii] See Ostrom's 2009 Noble lecture.
[xxiii] The Oslo Accords created the Palestinian Water Authority (PWA) and Joint Water Council (JWC) that complement Israeli institutions. See Amnesty International 2009 pp. 33-40 for a more jaundiced view of the JWC.
[xxiv] The use of an annual water flow is, *per force*, less contentious than the outright ownership, control and use of the entire water stock (i.e. all future annual flows) both because it is less valuable and because it is less final.

[xxv] This may vary due to "lean against the wind" operations by the Water authority under conditions of high seasonal rainfall or drought.We envisage that the Joint Water Authority be given duties, and the powers and independence necessary to exercise them, similar in character to those of a Central Bank.

[xxvi] That is, a single price for water of a given quality and consistency. If agricultural water is of lower quality – for example, waste water - or is less reliably supplied then its price should reflect that.

[xxvii] See Darr et al., for a discussion of socioeconomic factors affecting water demand in Israel.

[xxviii] In this context consider Atkinson's Inequality measure $A = 1 - \left[\sum_{i=1}^{N} \left(\frac{y_i}{\mu} \right)^{1-\rho} f(y_i) \right]$ where y_i is i's income; μ is mean income; $f(y)$ is the income distribution. An inequality aversion parameter $\rho = 0$ is consistent with weak form efficiency; $\rho \to \infty$ is consistent with strong form efficiency and ρ takes an intermediate value for semi-strong form efficiency (see Atkinson 1970).

[xxix] These are; (i) Flexibility (ii) Security (iii) Paying the real opportunity cost (iv) Predictability of the outcome (v) Equity (vi) Political and public acceptability (vii Efficiency (viii) Sensitivity (ix) Public health and nutrition (x) Administrative feasibility and sustainability (xi) Fiscal impact (xii) Environmental impact (xiii) Policy reforms.

[xxx] See the World Bank 2009 p15 for a description of the West Bank's "fragmented" water infrastructure.

[xxxi] Like Samuel Beckett's Molloy, "*... revolving interminable martingales all equally defective...*"