Desalination, space and power: The ramifications of Israel’s changing water geography

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A B S T R A C T

Desalination alters a basic premise of water geography – fresh water flows from the sea inward, rather than the other way around. But, is this observation important? To address this question it is necessary to identify the potential ramifications of the changes in the water geography brought about by desalination. Israel is used as a basis for identifying these ramifications as it has recently embarked on a large-scale desalination program. The direct readily observable implications of the three main attributes of desalination, the reversal of flow direction, the continuity of water production, regardless of weather and climate vagrancies, and its cost are first spelled out. Then the potential ramifications for internal power structures, pricing and transboundary water agreements are discussed for the Israeli and Israeli–Arab scene. It is shown that the spatial flexibility introduced by desalination may undermine existing power relations within the water sector, which were based on the previous water geography. In the Israeli case these changes may be used to undermine the monopoly power of the national water company and of its organized labor, thereby advancing a neoliberal agenda. Desalination may have also significant distributional implications, as a function of the pricing effects it may have. Finally, the new water geography raises new issues in the Israeli–Arab water scene. The general insights gained from the Israeli case are then spelled out.

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1. Introduction

The geography of water – the sources, sinks and flow directions – is usually taken for granted. But with the advent of desalination a basic premise of the water geography is altered. Essentially, fresh water flows from the sea inland, rather than the other way round. This paper asks how important is this observation. To address this question it is necessary to identify the potential ramifications of the changes in the water geography brought about by desalination.

With rising global water stress, measured by the ratio of fresh water usage to discharge (Vorosmarty et al., 2000), leading to the closure of an increasing number of basins (Falkenmark and Molden, 2008; Molle, 2008), and increasing demand, the willingness to pay for water rises (Gleick and Palaniappan, 2010). Hence, desalination becomes increasingly attractive in countries that can afford it. As the cost of desalination decrease (Khawaji et al., 2008; Bernat et al., 2010) while the GDP per capita of mid-income countries rises it is likely that desalination will increasingly be seen as affordable in a widening set of locales (Lopez-Gunn and Llamas, 2008). Thus while it is no panacea, and should be preceded by a series of preliminary steps, desalination is already being considered in a significant number of water stressed developed countries as a major source of water (Gleick et al., 2006; Lattermann and Hopner, 2008), and demand for it is likely to grow rapidly. Indeed, large scale desalination which was largely concentrated in the oil-rich Arab Gulf states (particularly Saudi Arabia and the United Arab Emirates) and in water-scarce islands such as the Canary Islands and Malta, is now vigorously debated in a wide range of locales around the Mediterranean, Australia, California and Latin America.

Israel is a particularly good case for analyzing desalination’s spatial implications as it meets most of the preliminary steps and

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requisites noted by Gleick et al. (2006) and Lattermann and Hopner (2008). This includes having a highly developed water system, which includes widespread inter-basin transfers, and demand management to augment supply (such as conservation, recycling and diversion of fresh water away from agriculture) (Tal, 2006). Moreover, as much of Israel’s freshwater are derived from shared resources, the transboundary ramifications of desalination can be discerned too in this case.

Israel is also suitable for examining the implications of desalination in a neoliberalizing environment, as in the past 20 years the nation-building discourse and statist economy have been largely superseded by a neoliberal ideology, espousing commercialization, privatization and commodification of services (Ben Porat, 2008). Examining of the role of desalination in a neoliberal setting may be of particular interest as it has been argued that due to its spatiality, embedded in natural basins with little inter-connections between them, water is an ‘uncooperative commodity’ and thus somewhat resistant to neoliberalization (Bakker, 2005). By examining the implications of desalination in Israel, and particularly the implications of its spatial flexibility, it is possible to examine whether desalination indeed de-spatializes water, and hence the role it may play in advancing the neoliberalization of nature. This we do from a grounded theory perspective, whereby we derive the theoretical implications of the new geography induced by desalination on the basis of the Israeli case study.

In the next section a brief historical background of the development of the Israeli water geography is presented, followed by a preliminary outline of the new emerging water geography. First the desalination plan currently being implemented is described. Then the direct implications of this plan for future flow directions and for recycling options is discussed. Based on this discussion and the observation that desalinated seawater is likely to become a base-flow for urban supply, insensitive to weather and climatic variation, three possible second-order ramifications of the new Israeli water geography are identified.

The first pertains to the intra-Israeli governance of water resources. Here it is argued that desalination reduces the monopolistic power of the existing national water company, and can therefore be seen as advancing the neoliberalization of the Israeli water sector, primarily by allowing greater devolution and wider privatization of water supply – which in turn contribute to the concentration of power and wealth. At the same time, desalination may lead to greater concentration in the wastewater business, with ambivalent effect on neoliberalization trends. The second pertains to pricing. Here it is argued that the new water geography alters the “marginal cost map” of water supply, thereby potentially changing cross-subsidization patterns, with significant social ramifications. The third pertains to the regional Arab-Israeli level. Here it is shown that the new water and flow directions have important implications for negotiations and raise several new issues that have not been adequately addressed in the voluminous literature on this case study. Then, the practical and theoretical insights gained from the Israeli case are discussed, followed by conclusions regarding the general ramifications of desalination for intra-national and inter-national power relationships.

2. The Israeli water geography: A brief history

In the history of the Israeli/Palestinian water geography we discern four eras. In the first (pre-modern) era, which extended in Palestine until the late 1930s, the scale of most water supply systems was largely local, conforming to Feitelson and Fischhendler’s (2009) individual or community scale. Water was supplied from cisterns, wells and springs (Ron, 1985; Rubin, 1988), with only a few cities and towns (such as Jerusalem) supplied from non-local sources; usually by Roman-based water systems. With the exception of the Jordan River which flows from north to south, all streams flowed either eastward toward the Jordan River and the Dead Sea, or westward to the Mediterranean.

The second era, beginning in the 1930s can be viewed as the largely Zionist hydraulic mission era. In the early years (pre-1948) of this era several large scale water conveyance schemes were conceived, suggesting inter-regional north-to south water conveyance, and the first regional projects of the modern era were built, some by the Zionist bodies (Blass, 1973) and some by the British Mandate authorities. In order to implement these regional schemes, whose purpose was to facilitate the Zionist settlement plans, the Mekorot water company was formed. After independence in 1948, Israel commenced on several large-scale water conveyance schemes, which culminated in the inauguration of the National Water Carrier (NWC) in 1964, thereby forming a national system that conveyed water from the relatively water-rich north, southward (Weiner, 1960). These efforts, influenced by the Tennessee Valley project in the United States, were driven by geo-political concerns and a nation-building ethos that gave precedence to agricultural development (Galnoor, 1978; Harris and Alatout, 2010). The resulting water geography, seen in Fig. 1, essentially comprised three storages (Lake Kinneret, the Coastal aquifer and the western mountain aquifer), which were connected via the NWC, in which water flowed from north to south, toward the main locus of domestic consumption in the coastal plain and the highly productive farmland in the northern Negev. As a result the main water flow in Israel transacted the natural east to west flows of the coastal streams, integrating them into the national system, thereby consolidating Mekorot’s power over all facets of the water systems.

The third era can be defined as the fresh water closure era. By the Seventies all the fresh water resources in Israel were being utilized, leaving very little to flow into any of the sinks, whether the Mediterranean or the Dead Sea (Gvirtzman, 2002). The closure of the Jordan River was further compounded by the growing demand for water in Jordan (Venot et al., 2008). As a result the emphasis shifted in Israel to the management of the existing resources (Galnoor, 1978). Based on the Water Law, ratified in 1959, which annulled private ownership of all water resources, the administration of the water system was placed in the hands of a Water Commissioner, appointed by the Minister of Agriculture. The Water Commissioner was given wide discretionary power to determine water abstractions and allocations, all of which are metered. This system was extended to the West Bank and Gaza after their occupa-

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5 The neoliberalization of nature has been widely discussed and theorized in recent years. We do not repeat or summarize this literature as McCarthy and Prudham (2004) and Castree (2008a,b) provide excellent overviews and reviews of it. Rather, we take Bakker’s (2005) typology of neoliberalization of nature as comprised of privatization, commercialization and commodification, and her more detailed differentiation of resource management reforms (Bakker, 2007, Table 1) as working definitions for this multi-faceted and otherwise rather nebulous term.

6 Feitelson (2007) discerned three eras of the water history of Israel since 1948 on the basis of the physical capital investment rates, institutional structure and dominant discourses in the water sector. To these we add a pre-modernist era.

7 Lake Kinneret, is also referred to as the Sea of Galilee and Lake Tiberias. These are used interchangeably.

8 While the occupation of the West Bank and Golan Heights allowed Israel to control an additional source of the Jordan River and all of the Mountain aquifers, it did not change the water geography significantly, as the Western and North-eastern Mountain aquifers were fully utilized within Israel before 1967, while the local sources on the Golan Heights are used primarily to supply the Israeli settlements built there after 1967.

9 On the political and power background to this law see: Alatout (2008) or Feitelson (2005).
tion in 1967 through military orders, thereby restricting the Palestinians’ ability to abstract additional water from the aquifers underlying these areas.10

To further facilitate the integration of the national system an equalization fund was established to equalize water rates across space (Harris and Alatout, 2010). In this way the geographical differences in water supply costs were masked, and all users were assured the same level of supply at the same price, regardless of actual cost of delivery (Kislev, 2006), thereby supporting farming in peripheral areas, and particularly the semi-arid south and the mountainous north.

In this era water management was controlled by a technocratic elite that pursued a ‘wise management’ approach, whereby sophisticated data-based models were used on the supply side in tandem with water conservation in the agricultural sector and wastewater treatment and re-use. As a result Israel came to be seen as a world leader in these two fields (Postel, 1997). These two complementary efforts allowed Israel to decouple agricultural production from fresh water supply, as agricultural product (and even more so the marginal value of agricultural product) rose sharply since the early Seventies, while water allocations to agriculture increased modestly and later declined (Fig. 2). Still, as competition over water increased, due to the rise in domestic use, water commissioners that came from the agricultural sector took a ‘brinkmanship’ approach, whereby they allowed water levels in Lake Kinneret and the aquifers to drop in order to maintain, and even increase, agricultural water allocations (Feitelson et al., 2007).

Consequently, several crises occurred since the late 1980s, triggered by a series of droughts. The evident difficulty of the Israeli system to avert these crises or to cope with them has been attributed by Feitelson (2005) to a political impasse between the Treasury and the agricultural lobby. The Treasury blocked augmentation of supply, mainly by desalination, while the agricultural lobby in the Knesset blocked attempts to raise water rates, thereby forcing the Water commissioner to manage increasingly stressed resources with very limited options to augment supply or manage demand.11 This impasse lasted until the severe drought of 1998–2001 led the government to approve wide-scale desalination, thereby inaugurating the fourth era, which is the focus of this paper.

3. The emerging Israeli water geography

The term water geography is not clearly defined in the literature. In this paper we refer to the geography of blue and gray water flows and storages, whether in natural courses, in lakes and aquifers, or in artificial canals, pipes and reservoirs. We therefore adhere to the view of the water cycle as comprised of both natural and human-induced flows (Linton, 2008). In this vein various researchers have shown that water flows are a function of power and money (Reisner, 1986; Swyngedouw, 1999). In line with this definition of water geography we first outline the desalination plan, and then the implications it may have on water and wastewater flows.

3.1. The desalination plan

Until 2000, desalination in Israel was limited to small plants processing brackish water in remote areas, which were not con-

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10 The institutional integration was followed by physical integration, as pipes were laid to convey water from Israel to settlements in the occupied territories. Several Palestinian cities and towns were connected to this network (Figs. 1 and 3). Still, despite the improved supply of potable water to Palestinian villages and towns a wide discrepancy remains in the availability and reliability of water supply between Israel and the West Bank.

11 The crises led to the formation of several inquiry commissions. The most important of these were the Arlosoroff Commission (1997), the Magen Parliamentary inquiry commission (2001) and the recent National Inquiry Commission (2010). The particulars of the crises and the propositions to address them are extensively described in the reports of these commissions, which serve as a basis for much of the discussion herewith.
nected to the national system. The crises faced by the Water Commissioner in the Nineties led him to propose large scale desalination along the Mediterranean coast and to prepare a strategic desalination masterplan (Dreizin et al., 2008). In practice desalination was approved in a piecemeal manner. A national physical master plan for the sites was approved in 2004, with seven sites and a potential of up to 775 million cubic meters (MCM). These sites are shown in Fig. 3.

In 2005 the first large plant in Ashkelon has come on line, producing 100 MCM per year. Since then two additional plants came on line. The first, a relatively small (37 MCM per year), plant at Palmachim, and the second a large (127 MCM) plant at Hadera (Fig. 3). All of these are being built by private capital through build-operate-transfer (BOT) tenders. Construction of a fourth plant, at Soreq, has begun in July 2010. The status and ownership of all current and planned plants, as well as their energy sources (where known) are summarized in Table 1.

The total capacity of the desalination plants shown in Table 1, including the utilization of additional capacity currently being added in Ashkelon and Palmachim, amounts to 592 MCM. This quantity can be compared to the amount of water that is being used, and the projections of use, by sector, presented in Table 2.

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The Water Authority (which replaced the Water Commissioner in 2007) initiated a new long term national water master plan in 2008. According to the first published draft of this plan desalina-
the coastal plain will be increasingly supplied from the new desalination plants, so as to save conveyance costs from the Jordan basin (Dreizin et al., 2008). As population densities in the south are low this may result in water being conveyed in the national water carrier from southern plants to consumers to the north of them, thereby reversing the flow in some parts of the NWC.14

As a result of the increasing supply of desalinated water for domestic use in the coastal plain and the south, the implementation of demand management in the domestic sector and the substitution of freshwater by recycled water in agriculture in the center and south (discussed in the next sub-section), the demand for water conveyance from Lake Kinneret southward is likely to decline. According to the very partially implemented interim plan of 2002 (which assumed that 540 MCM will be desalinated) the amount of water "exported" from Lake Kinneret through the NWC was to diminish by 100 MCM, which is a quarter of the NWC’s capacity. The most recent interim report of the new water masterplan being prepared states that most of the water derived from Lake Kinneret will be retained in the Jordan River basin to supply the increasing demand there (IWA, 2010). This change is likely to be facilitated by the greater reliability of desalinated and recycled water, which are insensitive to climatic variations. Thus, the historical conveyance of water from the north east to the south through the NWC is likely to decrease, thereby leaving more freshwater to be used within the Jordan River basin, while future conveyance will mostly be for shorter distances, and much of it from west to east.

### 3.3. The recycling geography

Until the early Nineties two large scale wastewater treatment plants (WWTPs) were built. The first (the Shafdan plant, operated by Mekorot) treated the wastewater of part of the Tel Aviv Metropolitian area and conveyed the treated wastewater to the western Negev for irrigation, after it had been filtered through the local sand aquifer. The second treats Haifa’s sewage and conveys the recycled effluents for irrigation in the western Yizrael Valley.

As part of the response to the 1990-1 immigration wave, Israeli environmental planners succeeded in making wastewater treatment a condition for large scale residential development (Feitelson, 1998). Subsequently many local and regional WWTPs were built. Today most cities have such plants. These have been largely commercialized as part of the treasury’s policy to corporatize the municipal water and sewer sectors, enacted into law in 2001, as part of the government’s neo-liberal agenda at the time. Hence, most of the WWTPs are operated by municipal companies, while others were built as BOTs.

14 The alternative of using desalinated seawater for agriculture in the south has been tried in the Ashkelon plant case. However, several difficulties have arisen due to the chemistry of the desalinated water (Yermiyahu et al., 2007). At present the water from the Ashkelon plant is used in the cities to its east and south-east, while the NWC is prepared for the flow reversal.
The advent of desalination allows for increased domestic use as well as for aquifer replenishment, as can be seen in Table 2. As a result of the increase in domestic use the amount of water available for recycling rises. According to the base water balance of the new water masterplan the amount of recycled water that will be available for agriculture will increase from 400 MCM in 2010 to 528 MCM in 2020 and 645 MCM in 2030. As the salt content in desalinated water is lower than in natural water, the quality of wastewater will also improve (i.e. its chloride content will decrease), in conformance with the trend toward more stringent standards pushed for by the Ministry of Environment (National Inquiry Commission, 2010). This will allow a wider array of crops to

![The Attributes, Effects and Ramifications of Desalination](image-url)
be irrigated with recycled wastewater and reduce the threats to the underlying aquifers (Tal, 2006), thereby postponing the need to desalinate recycled wastewater.

At present, with the important exception of the Shafdan, all WWTPs are local or regional and thus wastewater re-use is largely conducted at this scale. It is both a source of power for regional water authorities, and a liability on local jurisdictions that have to bear the operating and maintenance cost of the WWTPs. But, as the profitability of agriculture declines while land values rise, agricultural land in the coastal plain comes under increasing development pressure. Thus, while the supply of wastewater available for recycling increases, the potential for re-use in the central part of the country diminishes. Hence, the possibility of conveying recycled wastewater southward to areas with high agricultural demand has been raised, even though farmers are unable to pay the full conveyance costs. The options for such inter-regional conveyance were outlined in the physical masterplan. The implementation of these options is currently debated within the scope of the new water masterplan that is being prepared.

4. The ramifications of the new Israeli water geography

In addition to the reversal of freshwater flow, desalination programs are characterized also by the continuous flows emanating from them and their energy requirements, and hence cost. The discovery of natural gas fields of Israel’s coast significantly reduced energy costs. Still, to reduce the average cost desalination plants have to produce water all year round, regardless of the weather (Dreizin et al., 2008). Thus, while they are constructed as the marginal water source, desalination outflows are likely to be used as base flows to reduce the average cost,15 while the more ephemeral flows from natural sources will be increasingly regarded as the marginal water use. Desalination may induce, therefore, a fundamental change in water management practice. The continuous flow and cost attributes of desalination together with the spatial implications outlined in the previous section are the basis for discussing the potential ramifications of the introduction of desalination. The outline of the argument is presented in Fig. 4. In this figure the basic attributes of desalination are presented in full boxes while the first-order effects are in broken boxes. These first-order effects, discussed in the previous section, are those that can be discerned already in the Israeli plans and policies as they are formulated today, and can be seen as direct derivatives of the attributes of desalination.

These first-order effects have potential second-order effects (depicted as dotted boxes in Fig. 4). These are essentially pressures and reactions within the Israeli water polity, stemming from the first-order effects. Thus, while they can already be discerned in Israel, the practical outcomes of these second order effects are still uncertain, as these will result from the ongoing discussions and struggles. They are, thus, somewhat speculative. However, these possible ramifications are of the greatest interest from a social science perspective.

There are three inter-related groups of ramifications. The first pertain to the intra-national power relationships within the water sector and its governance. The second relate to the pricing implications of the higher cost and the changes in flow patterns and their potential distributional effects. The third type of potential ramifications pertain to the possible implications of the changes in flow directions for the management and allocation of transboundary water resources.

4.1. Power and water governance within Israel

As seen in Fig. 3 the NWC is the mainstay of the Israeli water system. Due to these economies of scale induced by the NWC the operation of the current Israeli water system is a national-level natural monopoly (Fischhendler and Heikkila, 2010). The operation of the NWC is thus at the core of the activities of Mekorot, and provides the rationale for its existence as a national water company.

Mekorot, whose origins are in the pre-state period, was designated as the national water company in the 1959 Water Law and entrusted with the operation of the national water system. It is largely financed by the state, which pays the difference between the company’s revenues from selling water (at state-regulated prices) and the total normative costs (differentiating between capital and operating costs) (National Inquiry Commission, 2010).

As the amounts of water conveyed by the NWC are likely to diminish following the introduction of large scale desalination, the NWC will turn from the main water conduit on which the supply of much of the country is dependent to a backup system, whose main purpose is to assure the reliability of supply. This will result in greater variance of the quantities of water that will be conveyed by the NWC. The operating cost of the NWC are a function of the time and direction of flow – as both energy requirements and energy rates vary by direction and time of day, respectively. Thus, as the variance in direction, time and quantities conveyed increase the variance of costs increases. Therefore, it can be expected that the pricing formula currently used will become increasingly irrelevant once the primary function of the NWC changes.

Moreover, as most of the water conveyance will be at the local/regional level the changes in the water geography will allow greater latitude in the management of local/regional systems, which will become more self-contained (IWA, 2010). This change may facilitate the breakup of the national unitary water system, into regional utilities backed up by a national water conveyance system. While the unitary national water system is a natural monopoly, and hence its privatization will not facilitate competition, regional utilities can be privatized either to users or to concessionaires thereby widening the options for decentralization and marketization of water, to use Bakker’s (2007) typology.

The breakup of Mekorot and the introduction of new private capital into the water system have long been promoted by the Treasury in order to allow for greater competition, and hence presumably efficiency, in the water sector, and reduce the power of organized labor (National Inquiry Commission, 2010). This proposition is in tandem with the neoliberal policies enacted in Israel since the late eighties, to privatize government enterprises and undermine organized labor throughout the economy (Kleiman, 1997; Ben Porat, 2008). In line with the tenants of the neoliberal discourse the breakup of Mekorot is seen by its proponents as an opportunity for new firms, possibly with international partners, to become a part of the water provision sector in Israel, thereby widening the financing options.16 For this reason Mekorot was barred from participating in the first desalination tenders issued (National Inquiry Commission, 2010). Mekorot was allowed, however, to build and operate one desalina-

15 In the BOT tenders the state invariably provides purchasing assurances to this end. Thereby a failure to use desalinated seawater as a base flow is likely to result in defaults. This can be seen in the case of Texas, where tenders that did not include such provisions failed (Eaton, 2011).

16 The proposition to breakup Mekorot and to prevent it from taking part in desalination in order to reduce its monopoly power appear already in the Arlosoroff Committee report of 1997, which espoused several tenants of market environmentalism including full cost pricing, corporatization of municipal water departments, and abrogation of the equalization fund. Most of these propositions were eventually enacted, at least partially. The breakup of Mekorot, and the impediments to its implementation are spelled by the National Inquiry Commission (2010).
tion plant, at Ashdod. Yet, by bargaining over the price at which the government will purchase the water the Treasury was able undermine Mekorot’s credibility in the desalination business to the extent that its ability to build the desalination plant in Ashdod has been questioned (Bar-Eli, 2011).17

In order to introduce new companies to the water supply sector the Treasury has striven to assure their profits. As the profits of these firms are a function of their ability to sell water continuously they, with support from the Treasury, strive to turn desalinated seawater into the base flow. In this they are assisted by the Water Authority, which is particularly concerned about the reliability of supply. As seawater desalination is insensitive to climate change and weather fluctuations, the use of desalinated water as a base flow increases the reliability of the water supply system. As a result of the use of desalinated water as a base flow more water is potentially left for aquifer replenishment and nature (IWA, 2010). Hence, environmental bodies support desalination, despite their misgivings regarding its negative externalities (Rosenthal et al., 2010). This issue is further discussed in the next section.

Clearly, the breakup of Mekorot and the loss of its monopoly power are viewed by it as a threat. For this reason Mekorot argued in the late nineties that it should undertake all desalination operations, an argument that was rejected by the neoliberal-minded treasury (National Inquiry Commission, 2010). The loss of monopoly power is of particular concern for the company’s unionized employees, who enjoy high salaries, who are likely to lose their power base. In order to stave off the threat to its power base the company has pushed forward large-scale integrative water projects.18

The most notable of these is the proposed north–south recycled water carrier. The formal discussions of this project, ongoing since the mid-nineties, involve the degree of risks it poses, the benefits that will be derived from it and its costs. But the underlying question raised by this project is whether wastewater recycling will become a national system, thereby augmenting Mekorot’s power and complicating the breakup process, or whether it will be managed on a regional basis. As there are no other institutions that are entrusted with operating a national wastewater system, Mekorot is positioning itself to become the ‘natural’ candidate for building and operating the new carrier.

The advent of multiple desalination plants on the Mediterranean coast has led some analysts to suggest that these plants can be directly linked, and owned, by municipal authorities (e.g. Shacham, 2002). In this alternative scenario tenders can be issued by municipalities, who can sell the excess water produced to the national system thereby advancing the commodification of the water sector. This alternative may allow differential water quality (above a minimal standard set nationally) and differential pricing for municipal water (an issue discussed in the next sub-section). However, in this case municipal water departments or utilities will have to undertake much more complex tasks than they perform at present, as they will be charged with long term planning of water production, while at present their purview is limited to the management of intra-city distribution systems. As both the municipal water departments and the water utilities set up to replace them are under attack, though for different reasons, by opposing parties, 19 it is not surprising that this option, enabled by the change in the water geography, has been opposed by both the local and national bodies, and ultimately was rejected.

4.2. Distributional and pricing issues

Water rates in Israel have been set in the past 50 years nationally, differentiated only by type of water (freshwater, recycled or brackish) and use (municipalities, industry or agriculture). Thus, water provided by Mekorot for a particular use was charged the same rates, regardless of the actual cost of provision, thereby eliminating the differential implications of space. Water provided by regional water associations or extracted by authorized private well owners is supplied at the cost of abstraction (to which an abstraction levy is added). This policy, implemented for equity and regional development reasons, has long been criticized by economists arguing for marginal cost pricing (Kislev, 2006). Such pricing proposals, essentially, view the cost of water conveyed in the NWC as the marginal cost, implying that the marginal price should rise from north to south (and from lower to higher altitudes).

The advent of desalination, and subsequent shift in the water geography, has provided fresh impetus to this debate. Essentially, the question is whether the new cost structure resulting from the new water geography should lead to a shift in water pricing, thereby furthering the commercialization of water. This question has differential implications for different users – domestic, agriculture and nature.

4.2.1. Urban and industrial rates

With the advent of desalination it can be argued that urban water rates should equal the marginal cost of water, which would be the cost of desalinated seawater at the city’s gate (including conveyance from the desalination plant to the city). In this case seaside cities in proximity to the desalination plants are likely to benefit from lower rates. If desalination is accompanied by devolution and commodification of water supply, such cities may even make a profit if they are able to sell excess water from plants they commission.

A regionalization of rates will raise, however, substantial distributional issues. The regions with high supply costs tend to be in the peripheral parts of the country – the upper Galilee in the north and the Negev in the south. These areas are also the weakest economically and socially, not least due to the sizable minorities within them. Moreover, both areas are relatively highly dependent on agriculture, and have few employment alternatives. These are, therefore, the areas that benefit most from the current cross-subsidization of water. Hence, a regionalization of water rates or the introduction of water markets is likely to increase the rates charged from the weakest groups in society in the most vulnerable parts of the country, while benefiting the stronger seaside cities in the country’s economic core.20

4.2.2. Agricultural water use and rates

The implication of a rise of fresh water rates and the increasing availability of a highly reliable supply of wastewater treated to high standards is a widespread shift of agriculture to recycled

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17 Originally Mekorot proposed to desalinate for 2.86 NIS per cubic meter of water. The treasury demanded that the price be reduced to 2.38 NIS per m³. After five rounds of negotiations Mekorot reduced its offer to 2.40 NIS per m³. But the agreement has not been signed at the time of writing. The conflict between Mekorot and the Treasury is spelled out in detail by the National Inquiry Commission (2010).

18 Mekorot has also a direct incentive to advance inter-regional conveyance schemes as under the current formula the compensation it received from the government is a function of its capital outlays, personnel and energy costs and technological risk, which are higher in inter-regional schemes (National Inquiry Commission, 2010).

19 The municipal water departments have been criticized for allowing mayors to cross-subsidize other municipal services from water and sewage fees, inefficiency and neglecting the upkeep of these systems (Ben Ilya, 1998). This has been the rationale for the corporatization of municipal water. Yet, the water utilities set up under the 2001 law are currently blamed by local authorities for the increase in consumer water bills.

20 In practice equal rates have been retained in Israel, indicating a preference for social over economic considerations (National Inquiry Commission, 2010).
wastewater in all parts of the country except the upper Jordan Valley (Amador et al., 2010), as can be seen in Table 2. While the recycled water used in the coastal plain will come from nearby urban centers, the recycled water that can be used in the south has to be conveyed from the densely populated central region, thereby raising the cost of providing it. In the upper Jordan Valley there is only scant urban population and thus the potential supply of recycled wastewater is limited, and wastewater recycling is heavily regulated as it lies within the Sea of Galilee basin area. Hence, agriculture in this area is likely to remain dependent on the local (relatively abundant) fresh water sources. This differentiation has important implications for analyses of the effects of pricing policies.

As the supply of fresh water is limited, demand is rising and the marginal cost of supply will rise with desalination, the price of fresh water for agriculture is likely to rise too. At the same time, the supply of recyclable wastewater will increase as a result of desalination and increasing domestic use, while the potential demand of agriculture is likely to be more limited due to the increasing environmental constraints on farming and the loss of farmland to urbanization in the coastal plain. Hence, the market price of recycled wastewater is likely to decline. But, as the standards for re-use of wastewater rise, the cost of treatment rises too. If farmers will be forced to bear some of these additional costs the demand for recycled wastewater will decline, possibly leading to excess treated wastewater. Therefore, it seems that if recycling is to be encouraged, the price of recycled wastewater has to be subsidized. In particular it will be necessary to subsidize the conveyance of treated wastewater for recycling in the south. This can be justified by the positive externalities of agriculture (Rosenthal and Erez, 2010).

The different dynamics outlined above may lead to a bifurcation in the cost of water for agriculture. In the northeast agriculture will continue to be based on freshwater, whose price is likely to rise over time, while in the rest of the country agriculture will increasingly utilize recycled wastewater, whose quality is likely to rise, and whose price for farmers may decline. This will be dependent, however, on the extent to which conveyance of recycled wastewater to the south will be subsidized. Such subsidization will have major repercussions for the northern Negev, where there are no readily available alternative sources of employment.

4.2.3. Price of water for nature and stream rehabilitation

Following the rising environmental awareness in Israel in-stream flows have been receiving increasing attention since the early Nineties. Stream rehabilitation became a central tenet of the new environmental planning doctrine (Feitelson, 1998). In 2000 the government allocated 50 MCM for nature and stream rehabilitation. Still, until the 2005 modification of the Water Law, water was retained for nature only through ad hoc agreements between the Water Commissioner and the Nature and Parks Authority (or their predecessors, the Nature Reserve Authority and the National Parks Authority). Since 2005 nature is a ‘legitimate’ use, to which water can be allocated under the Water Law. With the advent of desalination more water can be retained in the natural systems and reservoirs. Indeed one of the goals of the new masterplan being prepared is to raise water levels in the aquifers thereby allowing more water to flow out of the natural outlets (springs). This is reflected in the allocation of 50 MCM to nature and 200 MCM for aquifer replenishment (Table 2). The environmental NGOs though demand that the quantity of water designated for nature will rise further as additional desalination plants come on line (Rosenthal et al., 2010).

These developments raise the question how should water allocated for nature be paid for. At present the Nature and Parks Authority pays for the water allocated to nature reserves and national parks, and is reimbursed from the general coffer. This arrangement has been challenged by environmental NGOs and academics. They argue that as water retained in-stream does not incur capital or energy cost of supply it should not be charged or should be subsidized by the water authority (Rosenthal et al., 2010). It can be argued, however, that the water in nature has a positive shadow value, as it has profitable alternative uses, and thus the stream authorities and the Nature and Parks Authority should pay the shadow price. At present it is too early to tell whether any of these arguments will affect the pricing of the water (and wastewater) allocated to nature and stream rehabilitations. For the purpose of this paper, however, it suffices to note that the additional fresh water made available for nature and stream rehabilitations due desalination opens the way for a new set of arguments regarding the pricing of this water.

4.3. The Israeli–Arab water setting

Most of Israel’s fresh water resources are shared. Israel shares the Jordan basin with four co-riparians and the mountain aquifers with the Palestinians (Fig. 1). The allocation of these resources and the options for managing them have been widely discussed (Moore, 1994; Shuval, 1995; Wolf, 1995; Haddad et al., 2001; Phillips et al., 2007). In recent years there is a growing consensus that regardless of the exact allocation principles augmentation of the fresh water resources will be needed in the near future (Phillips et al., 2007; Venot et al., 2008; IWA, 2009, 2010). While water transfers from Egypt or Turkey are technically possible, they incur significant pecuniary costs and are politically problematic (and hence face prohibitively high transaction costs). Desalination is viewed thus as the most readily available source for augmentation (Sanders, 2009). However, the ramifications of desalination in this transboundary setting received only scant attention.

The Israeli position regarding desalination is that each party should have its own desalination plant(s). To this end Israel has reserved land near Hadera for a Palestinian desalination plant (see Fig. 3) promising to allow a Palestinian pipe to transverse its territory from Hadera to the West Bank (Gvirtzman, 2009). From a spatial perspective it is important to note that desalination along the Mediterranean sea coast will turn Israel from a lower riparian in the Jordan River to an upper riparian with regard to desalinated seawater, at least with regard to the West Bank thereby potentially widening the power discrepancy in its favor. This outcome can be viewed as generic, as the seaside parties, which often were the lower riparian when surface water flows were concerned, are the upper riparian with regard to desalinated seawater flows.

Due to this potential power exchange Jordan has advanced a Red Sea to Dead Sea water canal rather than for a cheaper canal from the Mediterranean to the Dead Sea. Moreover, the route of the proposed Red to Dead Sea canal is exclusively in Jordanian territory, thereby precluding the possibility that Israel will be an upper riparian on this canal.

The Palestinians demand that Israel will reduce its abstractions

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21 A contrary argument can be made that the natural state of water is in nature, and thus, if anything, nature should be compensated on the water taken from it. While this line of argument does not conform to the current Israeli Water Law, it is an argument that has been voiced by environmentalists in the Israeli water discourse. See: http://www.zalul.org.il/nehalim/.
22 As the focus of this paper is on the ramifications of the geographic implications of desalination, and not on the Israeli–Palestinian conflict, we do not present the positions and grievances of the parties regarding the outstanding water issues among them. These have been presented at length in many studies (see for example: Wolf, 1995; Shuval and Feitelson, 2002; Phillips et al., 2007; IWA, 2009). Rather, we present only the parties’ stances regarding desalination.
from the shared Mountain aquifer and the Jordan River and substitute for this water through desalination. While the Palestinians realize that even if their demands are accepted they will require augmentation sometime in the more distant future, they suggest that an international body will be established to coordinate and oversee the transboundary water issues, including the need and timing of desalination, thereby offsetting the potential advantage of Israel as an upper riparian with regard to desalinated seawater relative to the West Bank (Phillips et al., 2007).

The difference between Israeli and Palestinian positions implies, however, that several wider issues are at stake in addition to the clear power relationship. The first is to what extent desalinated seawater should be considered a substitute for freshwater resources. While the Israelis essentially imply that the potable water produced from seawater by industrial processes should be considered as an industrial product, whereby each party may desalinate as much as it desires as a function of the costs and benefits it perceives, and hence desalinated seawater is not a shared natural resource or a substitute for it, the Palestinians view desalinated seawater as a direct substitute for freshwater from natural resources.

A second issue is the extent to which storage capacity should play a role in transboundary water agreements, the importance of which was noted already by Dudley (1994). This issue has particular ramifications with regard to desalination. Water can be stored (in contrast to electricity). Thus, desalination plants can be built to supply a base flow that is below the multi-year average demand, while the naturally replenished and stored water supplies the remainder. Essentially, desalination allows for a higher level of storage to be kept to address inter-annual variations thereby improving the reliability of supply. Conversely, the loss of storage capacity (the Mountain Aquifer in Israel’s case) diminishes the ability to address inter-annual variations thereby necessitating the building of additional desalination plants, whose utilization may be sub-optimal. This consideration was seemingly central in the Israeli position in previous negotiations, where Israel insisted on retaining control over the full storage capacity in both the Sea of Galilee and the western Mountain aquifer (Feitelson, 2006). This raises a third issue – who should bear the additional costs of desalination, particularly if storage capacity of the desalinating party is reduced and hence the cost of desalination increases. In the future this issue may be extended to the question at whose expense should the additional greenhouse gas (GHG) emissions due to desalination be counted, if all parties have a GHG budget and targeted reductions.

5. Discussion: the spatial ramifications of desalination

Several insights can be gained from the Israeli case. Perhaps the most important insight pertains to the importance of the spatial flexibility introduced by desalination. In essence, desalination plants can be placed in a wide variety of sites along the shore, regardless of the natural water system. Hence, the new geography they induce can be divorced to a substantial degree from the existing water geography, thereby reconfiguring both the spatiality of water and the power relations within the water sector. By reconfiguring the spatiality of water desalination has the potential to overcome one of the main obstacles identified by Bakker (2005) to the neoliberalization and particularly the commodification of water – the limits to trade due to the spatial fixity of water systems.

In the Israeli case the new desalination plants are used to undermine Mekorot’s monopoly power and to advance devolution and privatization in the water field. But at present the potential of desalination to advance the commodification of water has been rejected. Therefore in Israel the potential of desalination to advance neoliberalism through spatial reconfiguration has been only partially realized. But in other contexts the potential shift in power may take a different tack, due to the specific power relationships in them. Thus, the potential of the new decentralized water production plants to alter the existing power structures, whether through the shift in flow directions, the disassociation from river basins, the introduction of new players and capital into the water supply system or the potential for new ownership patterns of water supply sources and hence to advance various facets of the neoliberal agenda cannot be overlooked.

Yet, the spatial flexibility of desalination may be constrained by economies of scale in desalination and by land, planning or environmental constraints. While small scale desalination plants can be built at the community or even household level, the economies of scale in desalination ensure that the cost of water from small plants will be higher than from large ones (Bernat et al., 2010). In the Israeli case it is already evident that the plans for additional desalination capacity will be mostly addressed in the vicinity of the currently planned sites, as the cost of opening a new site (which requires additional conveyance from the new site) are often substantially higher than expansion in situ (Dreizin et al., 2008). This advantage of existing sites is particularly evident in places where the coastal area is densely populated, as the social shadow price (including the internalization of externalities) in such contexts is high, given the keen competition that is likely to exist over coastal sites in such settings. This is the case in Israel where lack of land and relatively strict planning control have led to the increasing concentration of large-scale desalination around the sites seen in Fig. 3. While environmental concerns did not play a substantive role in the siting or development of desalination in Israel they may play a major role in other settings, particularly where reverse osmosis plants are planned along shallow bay areas with slow water turnover. In such cases the accumulation of brines and the energy demand of desalination may lead to the formation of an environmental opposition to desalination (Meerganz von Medeazza, 2005).

The introduction of new capital into the water sector through desalination BOT arrangements may have an additional implication for power structures. It may undermine the power of organized labor in places, such as Israel, where the water sector is highly centralized and highly unionized. The weakening of organized labor is one of the main tenets of the neoliberal agenda (Harvey, 2005). Thus, by its contribution to the weakening of organized labor and by shifting profits from water supply and the control of water infrastructure from the public to the private sector desalination may further the neoliberal agenda even if desalination is not used to advance the commodification or marketization of water.

As the number of sites and the number of potential suppliers is limited the market outcome of large-scale desalination tends to be a shift in power toward a privately-owned oligopoly rather than toward the competitive market espoused by the neoliberal discourse. This is the pattern that is emerging in Israel, where a single firm (IDE) has emerged as a market-leader (see Table 1). This firm is owned by the ICL group (50%), controlled by the Ofer brothers, and the Delek group (50%), which is controlled by Isaac Tshuva. The Ofer brothers and Isaac Tshuva are two of the most prominent members of the new capitalist class in Israel. Tshuva is also the main investor in the gas fields recently discovered off Israel’s coast. Hence, it seems that he is in the process of building a vertically-integrated energy–water conglomerate which will assure that
IDE will have an advantageous position in all future desalination tenders.

The Israeli case also suggests that the introduction of seawater desalination opens a host of options for altering pricing strategies. These pertain to all potential water uses, including of wastewater. The actual effects of the new water geography on pricing, inevitably, are a function of the local power relationships. At this point it is too early to see what the effects will be in the Israeli case. Thus, at this point all that can be seen is that the advent of large scale desalination and the new water geography it induces may lead to substantial shifts in water prices, and that these may have wide distributional implications. However, the specifics of these will vary by locale.

An additional insight that can be gained from the Israeli case is the close relationship between desalination and wastewater treatment and re-use. In essence, the new water geography generates also new wastewater geography. Thus, the tendency to discuss the two separately is misplaced. Rather, they should be discussed in tandem. In the Israeli case irrigation patterns and irrigation cost maps are very likely to be influenced by the new water chemistry induced by desalination. The exact layout of these effects is a function of the shifts in availability of wastewater resulting from the introduction of new water into the domestic sector, the level of treatment (which in turn is influenced by the standards promulgated) and the possibilities for re-use. These possibilities are a function of the agricultural practices, regulation and environmental sensitivity of potential irrigation areas. In Israel the largest potential for wastewater recycling is in the south, which is less sensitive from a geo-hydrological perspective and has more land available for agriculture. Yet, the control of wastewater in arid and semi-arid areas, where basins are increasingly closed, can also serve as a power base. Thus the exact configuration of re-use is likely to be a function of power structures within the agricultural sector and its ability to obtain state or urban funding for high level recycling and conveyance of the treated wastewater. In the Israeli case, where the agricultural sector has a strong lobby, and where Mekorot is searching for additional inter-regional conveyance, the struggle will increasingly be focused on the proposed large scale conveyance plan for recycled wastewater from the eastern part of the Coastal plain to the northern Negev.

Where there are shared and contested transboundary water resources desalination can open options for positive sum games. This has been shown to be the case in the Israeli–Arab, and particularly the Israeli–Palestinian case (Phillips et al., 2007; Rouyer, 2000; Sanders, 2009). Yet, the question whether desalinated sea water should be considered a direct substitute for natural fresh water is contested. In the Israeli–Palestinian case the introduction of desalinated sea water raises questions regarding the implications for storage capacity and regarding the distribution of costs. Thus, analyses that merely strive to reallocate water by assuming that desalination can serve as a direct substitute for the freshwater in natural systems overlook some of the more substantive issues raised by desalination.

An additional issue was raised by Allan (2001, p. 94), who suggests that Israel was hesitant to introduce desalination because it was wary that this will undermine its negotiating position. Whether this has been the case is unclear as there can be other explanations for Israel’s reluctance to introduce large scale desalination in the Nineties, mainly its internal political economy (e.g. Feitelson, 2005). Regardless of the Israeli–Palestinian case, the adoption of the position that desalinated seawater is a direct substitute for natural water may have deleterious ramifications if seaside parties adopt the logic raised by Allan and postpone desalination so as not to compromise their negotiating position regarding the natural water resources.

Finally, it can be observed from the Israeli case that, perhaps paradoxically, the ability to retain more water in the natural system may lead to a latent conflict arising between environmental interests and other riparian interests. This may be observed both at the international level and at the intra-national level. In the Israeli–Arab case this may arise with regard to the lower Jordan River. Environmental NGOs, led by Friends of the Earth Middle East (an Israeli–Palestinian–Jordanian NGO) have called for additional freshwater to be allowed to flow down the lower Jordan to the Dead Sea, possibly as an alternative to the Red-Dead canal, thereby allowing for the rehabilitation of this highly degraded part of the river (Gafny et al., 2010). However, both the Palestinians and the Jordanians are likely to lay claim to any water that will be allowed to flow down the Jordan River.25

6. Conclusions

The analysis of the Israeli case indicates that the water geographies that emerge from the introduction of desalination may have wide ranging second order ramifications. While some of the potential power and distributional ramifications identified in the Israeli case are specific to it, several general reconfigurations emerge.

As desalination opens the way for the introduction of new capitalist along the sea shore, it potentially undermines entrenched interests and institutions whose power stems from the existing water geography. Thus, desalination may serve to undermine the power of existing river basin authorities or similar bodies whose power is based on their ability to control water flows downstream through dams. Desalination can serve thus as a mean for overcoming the spatialities that hindered the neoliberalization of water.

As desalination plants are discrete projects that can be tendered separately, they have the potential to advance privatization, commodification and commercialization of water. But they do not necessarily do so. In Israel desalination is instrumental in promoting privatization and some devolution in the water sector, but it has not been used to advance commodification, while commercialization and corporatization of water were, arguably, advanced on their own merit (or demerit) with little reference to desalination. However, the relationship between desalination and neoliberalization should not be analyzed only from the perspective of market environmentalism, as this perspective does not capture the full scope of the relationship. By undermining the power of public authorities designated to manage natural water resources, desalination may undermine also the power of organized labor. By empowering and introducing private capital desalination can become an element in the redistribution of wealth from the middle and lower classes to the elite, which is perhaps the central feature of neoliberalism (Harvey, 2005). The new spatial configuration induced by desalination thus allows the water sector to become part of the empire building project of the new economic upper-class. In Israel this is manifest in the new ownership patterns of water production. It will not be surprising, therefore, if desalination is promoted by parties seeking to advance neoliberal agendas elsewhere too.

Desalination is most likely to be introduced mainly in arid and semi-arid regions. In these regions basins are increasingly being closed. The introduction of new water near the sea allows, potentially, for more water to be retained and used upstream. Perhaps paradoxically desalination may thereby ignite new struggles upstream between users over the perceived new surplus. In particular it may ignite struggles between environmental interests, who-

25 The Palestinians demand 200 MCM from the Jordan River on the basis of the Johnston accords, agreed upon but not ratified by the Arab states in the mid-fifties. Jordan can demand additional water too on the same basis.
ten were much weaker when the existing allocations were determined, and the extractive water users (such as agriculture). In the ensuing struggle water managers may choose to side with environmentalists, with whom they were previously at odds, as additional water in the natural systems will allow water managers greater leeway to address droughts, which are expected to worsen due to climate change. Concurrently, this confluence of interests may bring environmentalists to support neoliberal measures, such as full cost pricing and privatized desalination, despite their misgivings regarding the negative externalities of desalination. This has indeed been the case in Israel.

In settings where the desalinating party is the lower riparian on transboundary flows of natural water, the new geography may have implications for transboundary water agreements. In terms of power, desalination turns the downstream riparian into an upstream party with regard to produced water. However, the introduction of produced water raises a number of conceptual issues: to what degree is produced water a substitute for natural fresh water? Does desalination allow the desalinating party to reduce the water storage capacity it controls in favor of the up-stream parties? And how the costs of desalination should be borne by the parties? If the argument that desalinated seawater should be taken into account in determining the allocation of transboundary natural flows is accepted, then desalinating parties may find themselves in a disadvantage at the negotiating table, thereby undermining their readiness to embark unilaterally on desalination schemes. Thus, this study suggests that attempts to merely allocate shared freshwater resources among parties may be insufficient. If the issues noted above are not addressed the positive sum options opened by desalination may not be realized.

Finally, this study argues that studies of the new water geography have to take into account not only the produced and natural water flows but also the implications for wastewater treatment and re-use. In arid and semi-arid regions this additional fact may have important second order ramifications with regard to both the potential to retain additional fresh water in the natural systems and the power structures in the water sector.

This study is clearly somewhat speculative, given the early stage of large scale desalination coming on-line. However, the possibilities it identifies suggest that as a result of the introduction of large-scale desalination many new avenues for social science research are being opened. Analyzing the extent to which the optional ramifications outlined here materialize in practice may shed light on the underlying power struggles inherent in water.

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26 This can be seen in the policy document put out by all the major environmental NGOs (Rosenthal and Erez, 2010).