Projections • 14. New Uses for Old Rivers: Rediscovering Urban Waterways

Infrastructural instabilities of urban river restoration: Towards a metropolitan political ecology in the Tel Aviv region

Oren Shlomo¹ Nathan Marom²

¹The Open University of Israel & School of Sustainability, Interdisciplinary Center (IDC) Herzliya,

²School of Sustainability, Interdisciplinary Center (IDC) Herzliya

MIT Press

Published on: Dec 20, 2019

DOI: <https://doi.org/10.1162/00c13b77.705b9f95>

License: [Creative Commons Attribution 4.0 International License \(CC-BY 4.0\)](https://creativecommons.org/licenses/by/4.0/)

ABSTRACT

This article draws on the case of the Yarqon Restoration Project (YRP) in the Tel Aviv metropolitan region (TAMR) to highlight the infrastructural instabilities of urban river restoration and their theoretical implications. It analyzes the YRP as an outcome of multiple material interdependencies between “gray” and “green” infrastructures that are embedded in metropolitan-scale flows and politics. Methodologically, the article focuses on the main infrastructural projects constructed as part of the YRP and on subsequent polluting events that have since undermined the project. It uses data collected from policy documents, protocols, media coverage, and interviews conducted with stakeholders and professionals. The analysis shows that infrastructural instabilities are directly marked by the recurrence of “old” polluting uses within “new” recreational and ecological uses. These instabilities are deeply embedded in the metropolitan region’s unequal spatial-political structure, particularly disparities between upstream and downstream municipalities. We use the YRP case to develop a preliminary conceptual outline of a metropolitan political ecology, which highlights the spatial, environmental, and political complexities and inequalities of the metropolitan region and their consequences for the production of urban nature. This perspective extends the critical approach of urban political ecology, highlighting the metropolitan region as a critical scale at which natural watersheds intersect with geopolitical arrangements of territorial control, and at which environmental concerns are negotiated between numerous jurisdictions, conflicting land uses, and competing political-economic interests. The article suggests that metropolitan political ecology is a distinct and useful approach to understand not only urban river restoration but also other complex environmental issues.

Keywords

urban rivers; green and gray infrastructure; pollution; metropolitan regions; urban political ecology; Yarqon river

Acknowledgements

This research was supported by the ISRAEL SCIENCE FOUNDATION (Grant No. 1812/16).

Introduction

On July 20, 2011, the mayor of Tel Aviv-Jaffa, Ron Huldai, fulfilled his promise to swim in the Yarqon river. At that time, the river had a reputation of a polluted and toxic waterbody threatening the health and well-being of its surrounding neighborhoods and visitors. The aim of the mayor’s header was to bring to public awareness the success of the Yarqon Restoration Project (YRP). The rehabilitation project sought to restore the river’s ecological system and turn it into a green corridor in the dense heart of Israel’s central metropolitan region. Indeed, more than a decade of efforts has succeeded in restoring, to a great extent, the river’s ecology and placed it at the heart of the most popular recreational park in the Tel Aviv metropolitan region (TAMR).

However, since that momentous dive, the success of the YRP has occasionally been disrupted by polluting events, often causing mass fish deaths, turbid water, and bad smells. These events repeatedly undermine the stability of the restoration project. They also raise doubts about the river's new representation as a safe, recreational green and blue space.

In this article, we draw on the case of the YRP to better understand the infrastructural instabilities of urban river restoration and their theoretical implications. We analyze the restoration project as an outcome of multiple material connections and interdependencies between “gray” and “green” infrastructures that are embedded in metropolitan-scale flows, networks, and politics. We trace the ongoing risks and disturbances in the YRP and reveal how they evolve in relation to metropolitan-regional disparities between upstream and downstream municipalities, specifically their political and economic capacity and will to execute environmental policy. We find that the instabilities of the YRP are marked not only by the interrelations between “old” polluting uses and “new” recreational and ecological uses, but are embedded in the metropolitan region's socio-political structure, spatialities, and inequalities.

We build on the case of the YRP to develop a preliminary conceptual outline of a *metropolitan political ecology*. Our main objective is to highlight the spatial, environmental, and political complexities of the metropolitan region and their significance for understanding the production and maintenance of urban nature – restored urban rivers, in this case. This perspective aims to expand established approaches in urban political ecology (UPE) where the “urban” serves as the main locus of socio-natural metabolism (Swyngedouw et al. 2006). Much of the UPE literature focuses on the global-national scale of political economy as it interacts with the local-community scale of environmental politics, and examines how this impacts the urbanization of nature. Here, we seek to extend this view to highlight the importance of the metropolitan region for understanding socio-natural relations and their politics.

The analysis of these two dimensions of urban river restoration – the ecological-material and the spatial-political – indicates that the metropolitan region is a critical scale for environmental governance. It is at the metropolitan level that environmental concerns are negotiated between numerous jurisdictions, conflicting land uses, and competing political-economic interests, and that natural watersheds intersect with geopolitical arrangements of territorial control.

We explore these ideas and arguments by analyzing the main infrastructural projects that were constructed as part of the YRP. We also analyze subsequent polluting events that have threatened the project and highlight the linkages between them. Our data were collected from various sources, such as policy documents and plans, protocols from planning committees and environmental forums, media coverage, and interviews that we conducted with stakeholders and professionals. We set out to interpret these documents and interviews in light of our original research question, concerning the enabling conditions for recurrent polluting events in the restored river. But initial findings led us to broaden our perspective towards a regional river basin analysis. The

metropolitan region emerged as the proper scale for a more comprehensive understanding of the success and failures of urban river restoration.

The article proceeds as follows. The first section gives some theoretical background on urban river restoration as contingent on the interrelations of green and gray infrastructures, and sketches our argument on metropolitan political ecology in terms of scale and complexity of governance arrangements. The second section provides a brief overview of the environmental history of the Yarqon river, focusing on the “salvation” project since the 1990s and subsequent disturbances. The third and fourth sections offer in-depth analyses of these restoration instabilities. The third section explores the interdependence between gray and green infrastructures that make restoration at once possible and fragile. The fourth section contextualizes these instabilities within a metropolitan region characterized by stark socio-political inequalities between upstream and downstream localities. Finally, we conclude and elaborate how the analysis contributes to a metropolitan political ecology perspective.

From urban river restoration to metropolitan political ecology

Urban river restoration

Discussions of the urban-ecological evolution of rivers often start by portraying them as cradles of cities and providers of the necessary conditions for human settlement, such as fresh water, sanitation, waste disposal, irrigation, and mobility. This “fresh water” stage of urban rivers was altered during the rapid industrialization and urbanization of the 19th century, when rivers and waterways in expanding cities began to function as drainers and absorbers of the byproducts and wastes of these processes – from human sewage to toxic chemicals (Paul and Meyer 2001). Moreover, in order to protect growing cities from storm water and clear river floodplains for development, urban rivers were re-engineered to operate as flood control instruments. The result, in many cases, was their transformation to concrete drainage canals and the complete destruction of their ecosystem – a process sometimes described as “urban stream syndrome” (Walsh et al. 2005).

In recent decades, however, following the rise of the environmental movement, rivers have undergone yet another shift, as perceived by policymakers, planners, and the wider public. From functioning as drainers and sewage outlets, they have become objects of ecological restoration and sustainable planning, transformed into new green infrastructure providing ecological services and amenities (Kibel 2007). In this new environmental epistemology, urban rivers become an important nature-based solution for urban environmental problems and essential drivers for social and urban sustainability (Francis 2012; Smith et al. 2014). This evolution is often presented in a context of “old” (polluted, toxic) uses versus “new” (ecological, recreational) functions, implying a linear progress in the way urban rivers have been used, developed, and comprehended.

Green and gray infrastructure

The urban river restoration literature is largely dominated by the fields of environmental management and ecosystem services, offering environmental and economic justifications, methods to evaluate costs and benefits, and policy tools to promote river restoration (Brauman et al. 2007). The concept of green infrastructure also stems from this approach. It refers to the quantity and quality of urban green (and blue) spaces and ecological corridors, their multifunctional roles, the connectivity they provide between habitats, and the policies and technologies that enable them (Benedict and McMahon 2006; Tzoulas et al. 2007). Urban rivers are situated among other urban ecosystem components, such as street trees, parks, forests, wetlands, and lakes, all of which provide calculable ecological and social services that benefit communities and the urban environment. Here, we adopt a rather wide understanding of green infrastructure as the *living, non-built (vegetated and/or aquatic) environmental components and networks* which provide ecological services and improve the environmental and social sustainability of cities (Feng et al. 2017).

While ecologists focus mainly on the environmental and technical aspects of green infrastructure, in the last two decades, urban planners, geographers, and other social scientists have explored the social and political context of urban river restoration. This growing literature aims to expand the understanding of restoration projects beyond the natural-scientific aspects of river ecology, geomorphology, and conservation policy, and to explore also their social, cultural, and political aspects, such as relations between science, society, and policy (Eden and Tunstall 2006), participatory processes (Moran et al. 2016), or social responses and access (Johnson et al. 2018).

An important addition to this socio-political approach to urban rivers is to address also the dynamic, unstable interrelations between green and gray infrastructures. This focus reflects a growing critical engagement with networked infrastructures as “vast lattices of technological and material connections” (Graham and Marvin 2001) and with their effects on environmental sustainability, social inequity, and everyday life in urban areas (Broto and Bulkeley 2013; Graham and McFarlane 2014). Here, we define gray infrastructure as the *non-living, built systems and networks* that directly support human life and activities, including roads and transport systems, power and communication networks – and, in this case, water infrastructures, especially sewage and storm water drainage.

The analytical distinction between green and gray infrastructure enables us to specify more clearly the material connections that are involved in river restoration and in the production of urban nature more generally. It serves to unpack the technicalities, politics, and inequalities of flows of water and pollution in the restored river – through both green and gray infrastructure – in the context of its urban surroundings.

Urban political ecology

We situate our approach within the framework of UPE, which critically explores the relationship between natural, social, and political processes coming together in urban life, making and remaking particular urban

conditions (Heynen et al. 2006; Keil 2003). The UPE literature analyzes processes of “urban metabolism,” highlighting the constructed and contested ways in which cities consume natural resources, transform them into urban-industrial products and waste, and redistribute them inequitably between urban areas and communities (Broto et al. 2012; Wachsmuth, 2012). These metabolic processes involve complex infrastructural systems (including water and sewage) interacting with urbanized ecosystems (including watersheds and rivers). This perspective has been prolifically explored in relation to the urbanization of water as a politicized process (Gandy 2014; Swyngedouw 2004). It is also applicable to the politics of river restoration projects, which involve capital accumulation and commodification of new constructed nature (Robertson 2000), communities’ resistance (Fox et al. 2012), and contested land use regimes (Chung et al. 2018).

Towards a metropolitan political ecology

As we demonstrate in the case of the YRP, understanding the interdependencies and instabilities of gray and green infrastructures in the context of river restoration requires an *extended* UPE – one that goes beyond the city and pays attention to the scale of the metropolitan region. Indeed, UPE suggests that urban-environmental processes are not (only) place-based, nor are they confined to predetermined jurisdictions and territories. Rather, they evolve through material and capital flows (as well as discourses) generated at and between the local and global levels. This perspective stresses that the “urban” – as a distinct space and process – is a key site for a *multi-scalar* investigation of the changing forms of human production and consumption of nature: “the urban process harbors social and ecological processes that are embedded in dense and multilayered networks of local, regional, national and global connections” (Swyngedouw and Heynen 2003, 899). Thus, UPE emphasizes the importance of multiple scales to understand urban-environmental processes, but, at least in its early formulation, does not prioritize a particular scale.

We seek to add a concrete metropolitan dimension to UPE’s notion of the urbanization of nature, arguing that for many river basins and infrastructures, the metropolitan-regional scale is paramount. In other words, urban river restoration projects cannot be analyzed exclusively at the scale of the city, not only because they usually stretch far beyond its limits, but because their proper functioning depends on a range of technical, institutional, and governance arrangements across socio-political spatialities and urban-municipal jurisdictions. We thus posit that the analysis of urban rivers generally, and the YRP specifically, calls for a *metropolitan political ecology*. In this sense, our analysis contributes to the more recent, and underexplored, formulation of “megapolitan political ecology,” which highlights the “megapolitan” region as a particularly useful scale for understanding the function and flows of urban metabolism (Gustafson et al. 2014).

Our approach is also aligned with the literature on metropolitan regions and their diverse governance arrangements across municipalities and beyond jurisdictions – especially regarding environmental management, land use planning, and infrastructure and service provision. The challenges of environmental governance at the metropolitan scale are mainly ascribed to the prevalent spatial-political fragmentation and socio-economic disparities of large urban agglomerations, where numerous municipalities and authorities must

coordinate and compete while wielding unequal political power (Thiers et al. 2017; Wheeler 2009). This has been demonstrated with regard to incoherent urban planning and infrastructure development policies, leading to suburbanization and sprawl, or with respect to the lack of efficient cross-municipal public transportation systems. Others have stressed the highly unequal social and environmental consequences of fragmented metropolitan regions, including income inequality and environmental justice/racism (Benner and Pastor 2015; Pulido 2004). On the other hand, the existence of metropolitan governance bodies, cross-municipal authorities, and/or voluntary cooperation between regional actors may consolidate policies that better address regional environmental concerns (Ahrend et al. 2014; Rosan 2016).

Both UPE and metropolitan governance thus frame our investigation of the complex political ecologies of the TAMR, as investigated through the infrastructural instabilities of an urban river restoration project. From a metropolitan political ecology perspective, the YRP is seen as negotiated between different territorial regimes, namely Israel and the Occupied Palestinian Territories, numerous municipal jurisdictions of unequal power, conflicting political-economic interests, infrastructural investments and deficits, and uneven socio-environmental processes.

The Yarqon river “salvation” and its disturbances

The Yarqon river is one of the main coastal rivers of Israel. It flows along almost 28 kilometers (km) in the dense urbanized center of the country and across seven local authorities, from the foot of the West Bank hills westward, through the TAMR, before reaching the Mediterranean. The Yarqon basin, however, stretches over 1,800 km², beyond the metropolitan region, and includes also the basin of the Ayalon stream – the Yarqon’s main tributary. The larger basin, which within Israel consists of 36 local authorities and an area of over 800 km², covers over 1,000 km² beyond Israel’s pre-1967 borders in the Occupied Palestinian Territory of the West Bank. In the public eye, the river is associated with the popular metropolitan recreational park – the Yarqon park – developed around its banks in the jurisdiction of the cities of Tel Aviv and Ramat Gan. At the same time, it still evokes its dubious reputation as a toxic river and an environmental hazard.

Pollution and neglect

In the pre-urbanization era of the region, the Yarqon’s original high volume of fresh water flow (220 million m³/year) served several surrounding Palestinian villages for irrigation, buffalo raising, and water-power grain-mills. This included the village of Jammasin – in Arabic, water buffalo raisers – which in the 1940s neighbored the rapidly growing city of Tel Aviv. With the establishment of the State of Israel in 1948 and the forced displacement of Palestinian villages, the Yarqon river’s environmental history took a gloomy turn. In the 1950s, as part of a large state-building project, Israel diverted the water source of the Yarqon, from a karst aquifer located 13 km east of Tel Aviv, towards the semi-arid southern areas of the country. The cessation of most of its spring flows was the starting point for the river’s ecological deterioration from the late 1950s onwards (Gasith and Pargament 1998).

Throughout the following decades, rapid urbanization and industrialization of the river's basin – and particularly of the northern parts of the TAMR – caused severe pollution. The river effectively became drainage channel, especially for untreated sewage water from upstream localities. Further, the river channel and its surrounding areas became a destination for solid waste dumping, sand theft, criminal activities, and illegal fisheries. A routine of bad water color, smell, and mosquito breeding disrupted the well-being of the surrounding neighborhoods. The severe pollution and neglect of the Yarqon was tragically manifested during an international sport event in 1997, when a temporary bridge that was built over the river collapsed, causing the death of four athletes and injuring dozens as a result of coming in contact with riverbed toxics (Goldberg 2013).

Saving the Yarqon

Against this background, a public outcry emerged in the 1990s for the improvement of the river's ecological conditions and public safety. This was also due to a general increase in environmental awareness and activism in Israel, bringing about a shift in the legal and institutional frameworks for river rehabilitation (Tal and Katz 2012). These growing environmentalist attitudes contributed to the campaign to rehabilitate the Yarqon river and strengthen the Yarqon River Authority (YRA), which was established in 1988 and operated under the Israeli Ministry of Environment Protection.

The YRA's objectives are to rehabilitate the river's ecological system, prevent its pollution, and develop recreational landscapes along its banks. Its jurisdiction is limited to the river's channel and to a strip of 20 meters of land on each side. However, the YRA council consists of representatives from diverse governmental agencies and public organizations, to enable cooperation at the metropolitan scale and the entire river basin. The council includes eighteen members, including representatives of three government ministries, seven local authorities through which the river runs, seven corporations whose operations relate to YRA objectives, and a representative of the Israeli Land Management Authority (Pargament et al. 2010).

In 1996, the YRA board approved its first master plan, which presented a comprehensive environmental management framework for the channel within the wider basin area (Garcia and Pargament 2015a). Although not a statutory plan, it was approved that same year by the national government. In 2003, its principles were reinforced by a budgetary, schedule-based government decision. This decision put in action the "Yarqon Salvation Project" by stating detailed objectives and means for the rehabilitation of the river, prevention of upstream pollution, channel cleaning, recreational development, and the reuse of river water for irrigation. Most importantly, the master plan re-determined the river's water sources and allocations and segmented its 27.5 km into three distinguishable parts. These three segments differ in terms of water sources, water quality and quantity, and in the methodology and properties of restoration (see Figure 1).

Figure 1: Three sections of the Yarqon river (1: fresh water section; 2: middle (polluted) section; 3: salt water section) and adjacent municipalities. The “Green Line” shows Israel’s pre-1967 borders. Background map source: Google maps.

The three parts are:

1. The so-called “clean part,” fed by fresh spring water, includes the first 7 km from the river’s sources up to its confluence with one of its main tributaries – the Qana stream. Currently, this part is in relatively good ecological condition due to allocation from the Yarqon’s source springs by the Israeli Water Authority. While a major success of the restoration project has been the increase of the water allocation from 2.8 million m³/year in 2008 to 12.8 million m³/year in 2016, this still represents only 5 percent of the original historic flow of the river (YRA council meeting, May 9, 2017).
2. The middle section of the river runs from the confluence with the Qana stream along the next 16 km to the historical Seven Mills site. This segment was subjected to heavy industrial and sewage pollution, as the Qana stream was used for draining untreated and low-quality treated sewage from upstream localities. One of the achievements of the restoration plan has been the upgrading of two wastewater treatment plants (WWTPs) for the cities Kfar Sava-Hod Hasharon and Ramat Hasharon. Since 2011, these plants feed this section with tertiary high-level treated water, which amounted to 12.7 million m³/year in 2015 (Raz 2015). Another significant achievement is the construction of a wetland facility to further purify the Kfar Sava-Hod Hasharon WWTP output and stabilize the water quality.
3. The last 4 km of the river from the Seven Mills site to the estuary are called the “salty Yarqon.” In this section, the river’s water is composed mainly of sea water, which penetrates the river’s channel according to low and high tides – widening the channel and enabling kayaking and boating. It is the most developed section of the river and includes more than 3 km² of a popular recreational park, stretching on both sides of the river for about 6 km up the stream.

The forming of technical and administrative arrangements with the relevant municipal sewage authorities for ensuring the river’s water quality and quantity subsequently enabled the YRA and its restoration team to execute a range of activities for restoring the riparian ecological system. These included re-engineering river banks, channel cleaning, and restoring vegetation and species, including in-danger endemic fish. Furthermore, the river restoration enhanced the development of the river corridor as part of a larger metropolitan recreational park, which now includes amenities and bridges, walking trails and bike lanes along large parts of the river banks.

Declaration of success

In 2011, the YRP was declared as a success. Following the splashing of Tel Aviv's mayor, which attracted considerable media coverage, the chief manager of the YRA stated: "This year is a turning point for the Yarqon. We see fish in places that we haven't seen before; there is almost no need for anti-mosquito treatment ... there is a significant improvement" (Israeli Channel Two News, July 22, 2011). Further, in recent years, the Yarqon park has become the largest and most popular urban park in the country, attracting an estimated 5 million visitors each year (Images 1 and 2).

Images 1 and 2: The Yarqon park in Tel Aviv. Source: Nathan Marom.

The success of the YRP has been verified by public use rates and ecological flourishing. In addition, recent studies, adopting the lens of ecosystem services, suggest that the rehabilitation project will result in positive net present values of approximately US\$139 million over a 30-year period, particularly due to its provision of cultural ecosystem services (Garcia et al. 2016). This compares to approximately US\$24 million allocated in the 2003 government decision.

The Yarqon River Salvation disturbed

However, despite the large budget and professional knowledge that have led to the relative success of its "salvation," the Yarqon river still suffers from repeated pollution events, which destabilize the entire restoration project. The YRA samples water quality approximately twice a month at five stations along the salty western section of the river. According to data presented on the YRA website,¹ since January 2016, out of 83 tests conducted, 29 samples indicated severe pollution (more than 10,000 coliform units per 100 m/l) in at least one station, while 46 showed less-severe pollution (1,000-10,000 coliform units per 100 m/l).

Beyond such routine measurements, the Yarqon has suffered from irregular pollution events that resulted in severe damage to the restoration efforts. In most of these events, a polluted effluent (such as sanitary sewer water, oils, fuel, or fire retardant) finds its way to the river through adjacent municipalities or regional drainage networks and canals. Here, one of the main challenges of urban water body restoration is also a serious concern for the Yarqon: controlling the connectivity between the metropolitan drainage network and the river, and coping with numerous drainage management bodies at the municipal and regional levels (YRA general manager, interview, June 27, 2018).

One such overflow event occurred in 2008, when a fire in a furniture factory in an industrial zone in an upstream municipality spread to a detergent factory. The huge amounts of water used by firefighters, mixed

with spilled industrial detergents and fire retardants, reached the sewage system, and caused overcapacity and a total failure of the local WWTP. The result was the discharging of low-treated and untreated wastewater to one of the Yarqon's tributaries, covering the river with white thick foam for several days. As 106 tons of dead fish were collected and the entire aquatic ecological system destroyed, an official in the Israeli Ministry of Environmental Protection described the incident as an “ecological holocaust” that took the restoration project years back (Israeli Parliament Interior and Environmental Protection Committee, May 13, 2009; see Image 3).

Image 3: Foam covering the Yarqon during a large-scale pollutant event (2009). Source: Jonathan Raz, YRA.

Another prominent and frequent pollution source is the WWTP of the South Sharon Regional Council (SSRC), located in the northeast metropolitan area outskirts (see Figure 1). This plant was originally designed to receive 6,000 m³ of wastewater daily from relatively small localities from the SSRC and two adjacent municipalities. However, in the last ten years, it has received 24,000 m³ of wastewater per day, leading to overcapacity and frequent low-treated wastewater discharge into the Qana stream. In the last several years, this WWTP was the main cause for frequent bad water events and ecological damages to the Yarqon. Residents along the river and its streams experience severe environmental hazards of bad smells and proliferation of mosquitos while the river banks often become unpleasant spaces. These nuisances have stimulated a wide public discourse, complaints, and neighboring residents' campaigns, which criticize the authorities for failing to protect the river, the park, and their environmental wellbeing. However, residents' claims and even national media attention have fallen short of bringing a significant improvement while the construction of a new WWTP is delayed.

These two prominent examples are accompanied by many more mundane incidents such as sewage pipe breakdowns or blockages, even in relatively distant localities, or failures in industrial facilities that discharge polluted effluent. In most cases, the effluent eventually flows through the city drainage system or open canals into the Yarqon river. In the next two sections, we present a more detailed examination of what we conceptualize as *metropolitan infrastructural instabilities*, focusing on two facets: (1) the interrelations between green and gray infrastructure at the metropolitan scale, and (2) the metropolitan political ecology of upstream and downstream municipalities implicated in the restoration project and its disturbances.

Green and gray infrastructure interdependencies and instabilities

A closer interrogation of instabilities and failures in the YRP reveals that the proper operation of the newly constructed nature – as green infrastructure – is dependent on the governance of an array of gray infrastructural networks and WWTPs that are managed by diverse authorities across the metropolitan region. The following five infrastructural facilities and networks were designed to secure the stability of the YRP in general and to prevent polluted overflows in particular.

1. Upgrading two WWTPs (Kfar Sava/Hod Hashraon and Ramat Hasharon) whose output secures the needed amount of purified water inflow into the middle section of the river. This is the primary gray infrastructure operation that the entire project is premised on, as the WWTPs are the main providers of the river's life line and its ecological restoration.
2. The construction of wetlands near the river sources to further purify the inflow of treated water from one of the WWTPs into the river. The wetlands operate as a supportive green infrastructure to improve inflow quality and to stabilize fluctuations in WWTP output.
3. A reuse water system that collects water at the end of the middle section and channels it back to the upstream clean section in order to increase inflow volume.
4. A water collection and purifying system currently under construction just before the third, salty section to enable the reuse of river water for irrigation.
5. An array of stoppers and suspending devices designated to prevent sewage overflows from reaching the river. This includes a pumping station in the Qana channel that is designated to redirect overflows from the South Sharon WWTP to another plant.

These gray infrastructures have allowed reintroducing water from natural springs into the river, as well as setting an allocation regime from new man-made sources, namely high-quality treated sewage water (see Table 1).

Source	Quality	Quantity (million m ³ /year)
Natural springs	Fresh water	7.1
South Sharon WWTP	Secondary/low treatment (high turbidity)	2.5
Kfar Sava-Hod Hasharon WWTP	Tertiary treated	9.9
Ramat Hasharon WWTP	Tertiary treated	3.5
Total		23
Allocation for irrigation	From WWTP	1.4
Allocation for irrigation	From river	-1.5
Total in river		21.5

Table 1: Water allocation in the Yarqon, 2013. Source: Raz (2015, 69).

Yet, because the project takes place in a region of water scarcity, even reused water is contested by diverse actors and land users in the northern parts of the metropolitan region, mainly for the purpose of irrigation. In 2009, the mayor of Tel Aviv-Jaffa, who serves as the chairman of the YRA, described the new constellation as a “war over water.” This war, he predicted, would only intensify as the quality of WWTP output would improve significantly by 2011 and as demands for the reused water would grow: “We need to stop the processes of allocating [from the WWTPs] elsewhere and to protect the allocations to the Yarqon” (YRA council meeting, September 29, 2009).

The YRA addressed this anticipated contestation of reused water by arguing with local and national water agencies for the regulation of WWTP output in a way that would ensure a steady inflow into the river. This objective was to be supported by the construction of a water-purifying station just before the salty section of the river, which would further draw and purify water at the end of the middle section and redirect it for irrigation. This operation would effectively make the river not only a user of treated water produced elsewhere, but also a producer of reused water and an economically efficient project (Garcia and Pargament 2015b).

Yet, at the same time, the lifeline providers of the river, the WWTPs, also embody a destructive threat to the restoration project. In case of a major failure in one of these gray infrastructures, the available outlet would be the restored river. In anticipation of such failures, project discussions early on insisted that the restored river should not become “the available natural drainer” for the entire metropolitan region (YRA council meeting, August 5, 1999). With this in mind, the YRP also mandated the construction of an array of stoppers and suspending devices scattered in different municipalities in the TAMR’s urban and surrounding areas. This includes small dams, reservoirs, pumping and flow redirecting stations, designated to control effluent in the interface between the river and adjacent urban and open space drainage systems. On one hand, such drainage canals in upstream areas provide winter storm water for the river, thereby enhancing hydrological cleaning of the channel and the removal of silt from the riverbed. On the other hand, these drainage systems signal a threat to the river, particularly in summertime, when they discharge mostly undesired effluent originating from sewage breakdowns or other sources. Here again, this entails constant coordination and cooperation between local water and infrastructure authorities, and the regional drainage authority, as the general manager of the YRA explained in an interview:

There will always be failures. Our efforts focus on trying to think ahead, to predict the weaknesses and possible failures and try to neutralize them ahead of time. We are now in the middle of a basin-scale survey aiming to identify such potential pollutions. (YRA general manager, interview, June 27, 2018)

Thus, the YRP is at once dependent on, and an ongoing producer of, numerous gray infrastructures that are dispersed along the river throughout the metropolitan region. However, such infrastructure provision at the metropolitan scale is only one aspect through which the project’s metropolitan political ecology is manifested. In the case of the South Sharon WWTP, which is currently the main pollution source to the river, the threat to the restored river stems primarily from socio-political inequalities within the TAMR between municipalities

and their limited and differentiated capacity to execute planning and environmental policy, as the next section discusses.

Pollution and power flows between upstream, downstream, and transborder localities

The green-gray infrastructure instabilities of the Yarkon can only be understood at the scale of the metropolitan region as a whole. In the absence of a bridging metropolitan-level authority, these instabilities reflect unequal capacities of urban development and environmental management between different localities in the TAMR, as well as institutional tensions and conflicts between the local and national levels. Moreover, they are affected by ongoing urbanization of existing rural and peri-urban localities, and by the development of new suburban communities. To begin with, while metropolitan suburbanization around Tel Aviv has been going on for decades, through both expansion and “leapfrogging” (Benguigui et al. 2001), in the past decade or so it has gathered force on the metropolitan margins. Primarily, this is due to Israel’s high population growth (2 percent, versus 0.6 percent for the OECD), along with a rising standard of living and expectations of comfortable suburban lifestyles. More precisely, it has been shaped by a persistent housing crisis, with demand by new and expanding households outpacing new housing supply, particularly in the densely built core cities of TAMR. To address this problem, the government (through its National Committee for Preferred Housing Plans) has incentivized fast-track planning and construction of new neighborhoods and cities on open or agricultural land in the metropolitan outskirts. Meanwhile, infrastructure provision often lags behind and environmental considerations are pushed aside (Charney 2017; Mualam 2018).

This is also the context for the failure in the aforementioned South Sharon WWTP, which has sabotaged the YRP. The YRA general manager, seeing his long-time project damaged, suggests that this is not a technical or environmental problem, but rather the result of deficient decision-making and planning within the national government’s push to accelerate urban development:

This failure is a result of wrong decision-making processes of the State regarding sewage. The plant is designed to treat 6,000m³ from a specific population. First, this population has grown. Second, many other sources have been connected to this plant to solve infrastructure problems and to enable certificates of occupancy in new neighborhoods elsewhere. [...] The authorities should have persisted and avoided connecting these new sources until they have proper solutions. (YRA general manager, interview, June 27, 2018)

As the YRA manager implies, the South Sharon WWTP failure is part of a wider suburbanization “crisis,” pertaining both to the growth of existing localities and to the development of new suburban residential areas on the outskirts of the TAMR. The SSRC itself is a rural municipality, which includes 31 relatively small, mostly agriculture-based communities. It is located on the external ring of the TAMR and borders on the east with the “green line,” which separates Israel and the Occupied Palestinian Territories. Extending over 95,000 dunams

(nearly double the size of the city of Tel Aviv-Jaffa), it is a fragmented jurisdiction that fills in open spaces between the urbanized municipalities in the north-eastern part of TAMR. In the last two decades, the SSRC more than doubled its population size (from 15,000 to 32,000) due to suburbanization processes directed by national planning authorities. This includes three new “community settlements” (the “urban settlement” of Tsur Yizhak and the smaller settlements of Matan and Nirit), which effectively function as suburbs. As the head of the SSRC explained:

The South Sharon Regional Council can include new suburb-like localities. [...] But when all of a sudden, we need to include a new settlement of 3,000 units in high density construction of 15 and 17 stories ... – that means 12,000 people on top of our total population of 32,000. The implication is that the Regional Council will change its character and will not be able to provide basic services properly. (Tzur 2017)

Nevertheless, the failure of the South Sharon WWTP is a result not only of suburbanization within the SSRC itself and its subsequent inability to meet its growing needs, but also of the infrastructural needs and deficits of surrounding municipalities. Significantly, it provides services also to the Arab-Israeli city of Tayibe, with a population of more than 40,000. Here, it is important to note that Arab localities in Israel are ranked very low on the national socio-economic scale. They also suffer from structural discrimination in budgeting and development, especially in regard to allocation of land, infrastructure, planning and environmental conditions (Jabareen 2014). Thus, they experience severe housing shortage, leading to informal construction (Alfasi 2014), without concomitant investments in infrastructure or environmental amenities. This infrastructural distress was discussed in 2011 in the Israeli Parliament, following requests from Arab localities for a sewage solution to their approved expansion plans. At that time, Tayibe’s municipality was declared bankrupt and was administrated by an appointed trustee of the Ministry of Interior. He argued that the city cannot spend the requested amount for its contribution to upgrading the South Sharon WWTP – US\$10 million – as it amounted to almost 40 percent of the city’s budget (Israeli Parliament Environmental and Health Joint Committee, March 17, 2011).

Hence, the failure of the South Sharon WWTP also reflects the structural inequality of Arab cities in Israel. Yet, the political complexity of this WWTP – and of the consequent pollution of the Yarkon – goes even further, beyond Israel’s pre-1967 borders and deep into the West Bank. Here, polluted effluent from several Israeli settlements and from the Palestinian town of Qalqilya, which abuts the “green line,” is directed to the South Sharon WWTP (see Image 4). This cross-border pollution flow from the Occupied Palestinian Territories is the result of a gradual shift in the environmental politics of the Israeli-Palestinian conflict (following the collapse of the Oslo process around the year 2001), as Israel adopted an approach of “unilateral environmentalism” (Fischhendler et al. 2011). Hence, cooperation around untreated sewage discharge from Palestinian towns and villages is no longer handled through mutual environmental agreements (e.g. constructing shared WWTPs), but by developing one-sided solutions by Israel.

Image 4: The city of Qalqilya in the Occupied Palestinian Territories, seen from a sewage treatment basin near the South Sharon WWTP inside Israel. Source: Nathan Marom.

However, as the case of the South Sharon WWTP shows, unilateral environmentalism has significant disadvantages. In fact, the untreated discharge flowing from Qalqilya has been singled out by different Israeli authorities as the main source of the problem, perhaps to cover up their own inefficient measures. The WWTP’s management insists that its failures stem from “the huge scale of discharge transferred to the treatment plant whose source is, among others, the Palestinian Authority and the city of Qalqilya” (Koriel 2017). While such finger-pointing at Palestinians might be politically expedient, an Israel Water Authority report shows a more nuanced reality: while more than 60 percent of the population that the South Sharon WWTP serves resides in the West Bank, this population is nearly equally divided between Palestinian Qalqilya and Jewish settlements such as the town of Alfei Menashe, considered to be part of the TAMR outer ring (see Table 2). Thus, the detrimental consequences of Israel’s unilateral environmentalism – in this case, polluting the main river of its metropolitan center – are part of the wider spatialities of its control, occupation, and colonization of the West Bank (see Weizman 2007, 19).

Municipal authority	Number of localities	Population
South Sharon Regional Council	10	13,000
Tayibe – Arab-Israeli town	1	40,900
Israeli settlements in the West Bank	9	37,400
Qalqilya – West Bank Palestinian town	1	42,000

Table 2: Main sewage contributors to the South Sharon WWTP (2015). Source: Israel Water Authority (2015).

Further and importantly, the infrastructural instabilities of the YRP are embedded in an overall unequal metropolitan landscape, even if less ostensibly conflictual. The TAMR is a constellation of cities and localities that are highly unequal in their political capital, environmental conditions, and socio-spatial “distinctions” (Marom 2014). It encompasses the urban informality and infrastructural deficiency of Israeli-Arab Tayibe, the sprawling rural South Sharon settlements, the suburban mid-sized cities of Ramat Hasharon and Hod Hasharon

(which grew out of earlier agricultural settlements), the hyper-density and poverty of ultraorthodox Bnei Brak, and, at its center, the “global” city of Tel Aviv (see Table 3).

Municipality	Population size	Socio-economic rank²	Metropolitan region location	Upstream/downstream location
Tel Aviv	432,892	8	Core	Downstream
Ramat Gan	152,596	8	Inner ring	Downstream
Bnei Brak	182,799	2	Inner ring	Downstream
Ramat Hasharon	44,427	9	Inner ring	Middle
Petah Tikva	23,0984	7	Middle ring	Middle-upstream
Hod Hasharon	56,659	8	Middle ring	Middle-upstream
South Sharon	31,900	8	Middle ring	Upstream
Tayibe – Arab Israeli town	40,900	3	Middle ring	North basin area
Israeli settlements in the West Bank	37,400	5	External ring	East basin area
Qalqilya – West Bank Palestinian town	42,000	n/a	External ring	East basin area

Table 3: Municipalities affecting the Yarqon River.

Yet the Yarqon River “stitches” all of these localities together, making them mutually dependent in complex ways, and hence the success of the YRP is also contingent upon such material and socio-political dependencies. In the particular case of the South Sharon WTP failure, pollution generated by upstream, poorer, peripheral localities flows through downstream, privileged, central cities – Tel Aviv first and foremost – and “spoils” their most sought-after green environments. By contrast, power mostly “flows” in the opposite direction, be it through economic advantage or political domination, seeking (but so far failing) to create conditions that would fix downstream pollution.

Thus, the infrastructural instabilities of the Yarqon and its restoration project come to reflect political-economic and environmental inequalities between the metropolitan core and its margins. They reveal multiple levels of contestations: between dense and unaffordable city centers and rural suburbanization on the margins of the metropolitan region; between marginalized Arab-Israeli towns and the state's water and sewage authorities; and between Israel's green agenda of environmental protection and its unilateral control of Palestinian localities beyond the "green line." That is why the YRP must be contextualized, as we have contended here, within the metropolitan political ecology of the TAMR.

Conclusion: Towards a metropolitan political ecology

In May 2017, the mayor of Tel Aviv-Jaffa, Ron Huldai, addressed a letter to the Minister of Environmental Protection under the heading "Pollution in the Yarqon – We have had our fill!" (in the literal Hebrew expression: "Water has reached the soul"). The letter reads as an urgent plea to save the Yarqon project, and the mayor's own environmental legacy, symbolized by his plunge into the cleansed Yarqon only a few years earlier:

For many years, the Yarqon River Authority, which I head, has warned of the severe pollution caused to the river and its environment due to the sewage that is discharged without adequate treatment from the South Sharon WWTP. [...] For years, upgrading the WWTP has been postponed and dragged between different authorities. [...] Meanwhile, more and more sewage has been added to the outdated facility from many localities in its surroundings – up to four times its planned capacity – leading to its collapse. [...] We at the YRA stand powerless vis-à-vis this harmful conduct, which is not in our control, and watch how our many achievements in cleansing the Yarqon [...] go down the drain. [...] With every passing day we are retreating back to grim phenomena of mass fish dying, strong stench and mosquitos, which were already part of history in the Yarqon and hurt the wide public. (Blumental 2017)

The mayor's letter relates the controversy surrounding the South Sharon WWTP to the damage done to the YRP by reintroducing "old" polluting uses into the "new" recreational uses. It attests to the fragility of the revitalized river as an artificial, constructed nature, and alludes to the infrastructural instabilities at the heart of the restoration project: the fact that the new nature is immersed in an array of gray and green infrastructure. These infrastructures – drainage and sewage networks, treatment plants, wetlands, reservoirs, suspenders, dams, and pumping stations – serve as the river's guardians and providers – and at the same time, they embody the greatest threat for the entire restoration project. Hence, the "old" uses of rivers cannot be regarded as "part of history." Rather, they remain embodied in the metropolitan region's metabolic circulation as a latent possibility and a constant threat, one that may be unleashed in an incident of infrastructural "collapse."

The mayor's letter suggests an additional, critical insight pertaining to the metropolitan political ecology of the river and its restoration. It invokes the complex politics across the river basin, whereby relatively powerful cities downstream, led by Tel Aviv, find themselves "powerless" in the face of pollution and other environmental consequences emanating upstream, from poorer and peripheral localities. The highly

differentiated and extremely unequal cities and localities that make up the TAMR are entangled in a shared riparian environment, where basic hydrologic properties can unexpectedly complicate their mutual dependencies and power relations. Moreover, while we may realistically expect the particular infrastructural instabilities addressed here to be “solved” in the near future – through more infrastructural investment and technological deployment – these metropolitan structures of inequality are likely to produce more disturbances. From this viewpoint – seeing how the material connections and coordination between green and gray infrastructures are immersed in a fragmented grid of metropolitan governance – the Yarqon river becomes a prism through which the complex metropolitan political ecology of the TAMR is refracted.

From such a perspective, the case of the Yarqon river makes a significant counterpoint to one of the most basic propositions of both UPE and environmental justice – namely, that urban environments are predominantly constructed to the detriment of those with less power and capital. While these literatures usually focus on how racially ostracized groups, ethnic minorities, or other marginalized people are disproportionately more likely to suffer from a polluted or even toxic environment, in the Yarqon case, we see how river pollution that flows from disadvantaged communities in the periphery is adversely affecting the prosperous heart of the metropolis. Of course, these literatures acknowledge that environmental hazards might also impact better-off vicinities. And certainly, in the Yarqon case too, stronger municipalities like Tel Aviv enjoy much better environmental amenities than Bnei Brak, Tayibe, or Qalqiliya. Yet, it is also true that the topography and hydrology of the metropolitan region and river basin are structured in such a way that water pollution and power tend to flow in opposite directions.

The issues that we have highlighted here – the problematics of material connection and metropolitan coordination of green and gray infrastructures, the challenges of environmental governance in a fragmented and uneven metropolitan field of power, and the sometimes unexpected consequences of “downstream environmental justice” – are, separately but even more so jointly, manifestations of a metropolitan political ecology. We understand this as a concept and methodology that *extends and complicates* the critical insights of UPE on the material, social, and political dimensions of urban metabolic processes. Our notion of metropolitan political ecology pays attention to the expanded *scale* of the metropolitan region, which is critical for different metabolic flows (rivers included) and for many arrangements of environmental governance. At the same time, this perspective highlights the increased *complexities* associated with the metropolitan region, including its territorial and administrative fragmentation, its multiplicity of actors and institutions, its competing and overlapping land uses, and its socio-environmental and socio-political conflicts and inequalities. All this suggests that metropolitan political ecology is a distinct and useful approach to understand not only urban rivers restoration, but also other complex environmental issues.

References

- Ahrend, Rudiger, Catherine Gamper, and Abel Schumann. 2014. *The OECD Metropolitan Governance Survey: A Quantitative Description of Governance Structures in Large Urban Agglomerations*. OECD Regional Development Working Papers no. 4. https://www.oecd-ilibrary.org/urban-rural-and-regional-development/the-oecd-metropolitan-governance-survey_5jz43zldh08p-en
- Alfasi, Nurit. 2014. "Doomed to Informality: Familial versus Modern Planning in Arab Towns in Israel." *Planning Theory & Practice* 15, no. 2: 170-186.
- Benedict, Mark A., and Edward T. McMahon. 2006. *Green Infrastructure: Linking Landscapes and Communities*. London: Island Press.
- Benguigui, Lucien, Daniel Czamanski, and Maria Marinov. 2001. "City Growth as a Leap-Frogging Process: An Application to the Tel-Aviv Metropolis." *Urban Studies* 38, no. 10: 1819-1839.
- Benner, Chris, and Manuel Pastor. 2015. *Equity, Growth, and Community: What the Nation Can Learn from America's Metro Areas*. Berkeley: University of California Press.
- Blumental, Itay. 2017. "The Yarkon Pollution: Huldai Asks Alkin to Intervene." *Ynet*, May 17, 2017. <https://www.ynet.co.il/articles/0,7340,L-4963586,00.html>
- Brauman, Kate A., Gretchen C. Daily, T. Ka'eo Duarte, and Harold A. Mooney. 2007. "The Nature and Value of Ecosystem Services: An Overview Highlighting Hydrologic Services." *Annual Review of Environment and Resources* 32: 67-98.
- Broto, Vanesa Castán, Adriana Allen, and Elizabeth Rapoport. 2012. "Interdisciplinary Perspectives on Urban Metabolism." *Journal of Industrial Ecology* 16, no. 6: 851-861.
- Broto, Vanesa Castán, and Harriet Bulkeley. 2013. "Maintaining Climate Change Experiments: Urban Political Ecology and the Everyday Reconfiguration of Urban Infrastructure." *International Journal of Urban and Regional Research* 37, no. 6: 1934-1948.
- Charney, Igal. 2017. "A 'Supertanker' against Bureaucracy in the Wake of a Housing Crisis: Neoliberalizing Planning in Netanyahu's Israel." *Antipode* 49, no. 5: 1223-1243.
- Chung, Calvin King Lam, Fangzhu Zhang, and Fulong Wu. 2018. "Negotiating green Space with Landed Interests: The Urban Political Ecology of Greenway in the Pearl River Delta, China." *Antipode* 50, no. 4: 891-909.
- Eden, Sally, and Sylvia Tunstall. 2006. "Ecological versus Social Restoration? How Urban River Restoration Challenges but also Fails to Challenge the Science-Policy Nexus in the United Kingdom." *Environment and*

Planning C: Government and Policy 24, no. 5: 661-680.

Feng, Li, Xusheng Liu, Xiaoling Zhang, Dan Zhao, Hongxiao Liu, Chuanbin Zhou, and Rusong Wang. 2017. "Urban Ecological Infrastructure: An Integrated Network for Ecosystem Services and Sustainable Urban Systems." *Journal of Cleaner Production* 163: S12-S18.

Fischhendler, Itay, Shlomi Dinar, and David Katz. 2011. "The Politics of Unilateral Environmentalism: Cooperation and Conflict over Water Management along the Israeli-Palestinian Border." *Global Environmental Politics* 11, no. 1: 36-61.

Fox, Coleen A., Francis J. Magilligan, and Christopher S. Sneddon. 2016. "'You Kill the Dam, You Are Killing a Part of Me': Dam Removal and the Environmental Politics of River Restoration." *Geoforum*, 70: 93-104.

Francis, Robert A. 2012. "Positioning Urban Rivers within Urban Ecology." *Urban Ecosystems* 15, no. 2: 285-291.

Gandy, Matthew. 2014. *The Fabric of Space: Water, Modernity, and the Urban Imagination*. Cambridge: MIT Press.

Garcia, Xavier, and David Pargament. 2015a. "Rehabilitating Rivers and Enhancing Ecosystem Services in a Water-Scarcity Context: The Yarqon River." *International Journal of Water Resources Development* 31, no. 1: 73-87.

Garcia, Xavier, and David Pargament. 2015b. "Reusing Wastewater to Cope with Water Scarcity: Economic, Social and Environmental Considerations for Decision-Making." *Resources, Conservation and Recycling* 101: 154-166.

Garcia, Xavier, Corominas Lluís, David Pargament, and Vicenc Acuna. 2016. "Is River Rehabilitation Economically Viable in Water-Scarce Basins?" *Environmental Science and Policy* 61: 154-164.

Gasith, Avital, and David Pargament. 1998. "Practical Obstacles to Effective Implementation of Environmental Enforcement: The Case of the Coastal Streams of Israel." *Tel Aviv University Studies in Law* 14: 117-133.

Goldberg, Dan. 2013. "On Eve of Maccabiah, Survivors of 1997 Bridge Disaster Still Seething." *Haaretz*, July 16, 2013. <https://www.haaretz.com/israel-news/sports/.premium-on-eve-of-maccabiah-bridge-survivors-still-mad-1.5296082>

Graham, Stephen, and Simon Marvin. 2001. *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition*. London and New York: Routledge.

Graham, Stephen, and Colin McFarlane, eds. 2014. *Infrastructural Lives: Urban Infrastructure in Context*. London and New York: Routledge.

- Gustafson, Seth, Nik C. Heynen, Jennifer L. Rice, Ted Gragson, J. Marshall Shepherd, and Christopher Strother. 2014. "Megapolitan Political Ecology and Urban Metabolism in Southern Appalachia." *The Professional Geographer* 66, no. 4: 664-675.
- Heynen, Nik, Maria Kaika, and Eric Swyngedouw, eds. 2006. *In the Nature of Cities: Urban Political Ecology and the Politics of Urban Metabolism*. Oxon: Routledge.
- Israel Water Authority. 2015. *Water Regulation Unit Report*, July 7, 2015.
- Jabareen, Yosef. 2014. "'The Right to the City' Revisited: Assessing Urban Rights – The Case of Arab Cities in Israel." *Habitat International* 41: 135-141.
- Johnson, Eileen S., Kathleen P. Bell, and Jessica E. Leahy. 2018. "Disamenity to Amenity: Spatial and Temporal Patterns of Social Response to River Restoration Progress." *Landscape and Urban Planning* 169: 208-219.
- Keil, Roger. 2003. "Urban Political Ecology." *Urban Geography* 24, no. 8: 723-738.
- Kibel, Paul Stanton, ed. 2017. *Rivertown: Rethinking Urban Rivers*. Cambridge: MIT Press.
- Koriel, Ilana 2017. "The Yarqon Sewage Scandal: The Authorities' Disregard." *Ynet*, May 17, 2017. <https://www.ynet.co.il/articles/0,7340,L-4963381,00.html>
- Marom, Nathan. 2014. "Relating a City's History and Geography with Bourdieu: One Hundred Years of Spatial Distinction in Tel Aviv." *International Journal of Urban and Regional Research* 38, no. 4: 1344-62
- Moran, Sharon, Meredith Perreault, and Richard Smardon. 2016. "Finding Our Way: A Case Study of Urban Waterway Restoration and Participatory Process." *Landscape and Urban Planning* 191.
- Mualam, Nir. 2018. "Playing with Supertankers: Centralization in Land Use Planning in Israel – A National Experiment Underway." *Land Use Policy* 75: 269-283.
- Pargament, David, Richard Laster, and Dan Livney. 2010. "The Public's Role as a Stakeholder in the Yarqon River Authority, Israel." In Kate Berry and Eric Mollard, eds. *Social Participation in Water Governance and Management: Critical and Global Perspectives*, 219-239. London: Earthscan.
- Paul, Michael J., and Judy L. Meyer. 2001. "Streams in the Urban Landscape." *Annual Review of Ecology and Systematics* 32, no. 1: 333-365.
- Pulido, Laura. 2004. "Environmental Racism and Urban Development." In Jennifer Wolch, Manuel Pastor Jr., and Peter Dreier, eds. *Up against the Sprawl: Public Policy and the Making of Southern California*, 77-98. Minneapolis: University of Minnesota Press.

- Raz, Yehonatan. 2015. *A Report on the Status of the Yarqon River 2015/16*. The Yarqon River Authority (Hebrew).
- Robertson, Morgan M. 2000. "No Net Loss: Wetland Restoration and the Incomplete Capitalization of Nature." *Antipode* 32, no. 4: 463-493.
- Rosan, Christina D. 2016. *Governing the Fragmented Metropolis: Planning for Regional Sustainability*. Philadelphia: University of Pennsylvania Press.
- Smith, Benjamin, Nicholas J. Clifford, and Jenny Mant. 2014. "The Changing Nature of River Restoration." *Wiley Interdisciplinary Reviews: Water* 1, no. 3: 249-261.
- Swyngedouw, Erik. 2004. *Social Power and the Urbanization of Water: Flows of Power*. Oxford: Oxford University Press.
- Swyngedouw, Erik, and Nikolas C. Heynen. 2003. "Urban Political Ecology, Justice and the Politics of Scale." *Antipode* 35, no. 5: 898-918.
- Swyngedouw Erik, Maria Kaika, and Nik C. Heynen. 2006. "Urban Political Ecology: Politicizing the Production of Urban Natures." In Nik Heynen, Maria Kaika, and Eric Swyngedouw, eds. *In the Nature of Cities: Urban Political Ecology and the Politics of Urban Metabolism*, 1-20. Oxon: Routledge.
- Tal, Alon, and David Katz. 2012. "Rehabilitating Israel's Streams and Rivers." *International Journal of River Basin Management* 10, no. 4: 317-330.
- Thiers, Paul, Mark Stephan, Sean Gordon, and Alexander Walker. 2018. "Metropolitan Eco-Regimes and Differing State Policy Environments: Comparing Environmental Governance in the Portland-Vancouver Metropolitan Area." *Urban Affairs Review* 54, no. 6: 1019-1052.
- Tzoulas, Konstantinos, Kalevi Korpela, Stephen Venn, Vesa Yli-Pelkonen, Aleksandra Kaźmierczak, Jari Niemela, and Philip James. 2007. "Promoting Ecosystem and Human Health in Urban Areas Using Green Infrastructure: A Literature Review." *Landscape and Urban Planning* 81, no. 3: 167-178.
- Tzur, Shlomit. 2017. "My Recommendation to Head of Councils Is Do Not Meet Contractors." *Globes*, June 17, 2017 (Hebrew). <https://www.globes.co.il/news/article.aspx?did=1001241541>
- Wachsmuth, David. 2012. "Three Ecologies: Urban Metabolism and the Society-Nature Opposition." *Sociological Quarterly* 53, no. 4: 506-523.
- Weizman, Eyal. 2007. *Hollow Land: Israel's Architecture of Occupation*. London and New York: Verso.

Walsh, Christopher J., Allison H. Roy, Jack W. Feminella, Peter D. Cottingham, Peter M. Groffman, and Raymond P. Morgan. 2005. "The Urban Stream Syndrome: Current Knowledge and the Search for a Cure." *Freshwater Science* 24, no. 3: 706-723.

Wheeler, Stephen. 2013. "Regions, Megaregions, and Sustainability." In Michael Neuman and Angela Hull, eds. *The Futures of the City Region*, 123-136. Oxon: Routledge.

Footnotes

1. https://www.yarqon.org.il/en/water_quality/ ↵
2. Israel's Central Bureau of Statistics ranks all local authorities based on a combined socio-economic index, ranging from 10 for the wealthiest jurisdictions to 1 for the poorest. Palestinian settlements in the Occupied Palestinian Territories are not ranked in this index, but it can be assumed that Qalqilya's standing would be lower than Tayibe. For further details see: <https://www.cbs.gov.il/en/publications/Pages/2017/Characterization-and-Classification-of-Geographical-Units-by-the-Socio-Economic-Level-of-the-Population-2013.aspx>. ↵