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Inter-municipal cooperation for wastewater treatment: Case studies from Israel[☆]

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Received 10 April 2006; received in revised form 15 November 2006; accepted 10 December 2006

Available online 1 March 2007

Abstract

Since the beginning of the 1990s, local authorities in Israel have been engaged in promoting advanced Wastewater Treatment Plant (WWTP) projects throughout the country, resulting in the “wastewater treatment revolution” of the 1990s. These achievements are extremely important in the water-scarce country, as untreated or partially treated wastewater has become a major source of pollution of Israel’s fresh-water resources, and reuse of high-quality effluents can expand the national water potential. Many of these projects are regional schemes based on a central WWTP, serving a few neighboring municipalities. This paper presents two case studies of such regional cooperation: the “Karmiel Region Union of Towns for Sewage Treatment” and the “Treatment and Reuse of Wastewater in the area of the Hadera Stream, Ltd.” corporation. The findings suggest that regional cooperation can be an efficient tool in promoting advanced wastewater treatment, and has several advantages: an efficient use of limited resources (financial and land); balancing disparities between municipalities (size, socio-economic features, consciousness and ability of local leaders); and reducing spillover effects. However, some problems were reported in both cases and should be addressed.

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Keyword: Regional cooperation; Inter-municipal cooperation; Wastewater treatment; Israel

1. Introduction

In the state of Israel the local authorities: cities, local councils (small towns) and regional councils (federation of rural settlements) are legally responsible for the collection, treatment and sanitary disposal of wastewater generated within their boundaries (Gabbay, 2002). This paper focuses on wastewater treatment within urban settlements, as 92% of the inhabitants reside in towns and cities (in 2003).

Whereas most of the population (96%) has received adequate sewerage facilities for many years, wastewater treatment was very much neglected. Until the end of the 1980s the vast majority of urban settlements settled for the easiest and, unfortunately, the most polluting solution. Wastewater was collected and removed from population centers to the outskirts of the settlement, where it was either discharged untreated into the environment or treated in minimal-extensive wastewater treatment facilities (The State Comptroller, 1991). This was a convenient short-term arrangement for the local residents but of course disastrous in the long run.

Extensive facilities are low-tech, low-cost ponds, such as oxidation, stabilization and facultative ponds, in which natural processes of dissolution occur during lengthy exposure to the sun and atmospheric conditions (Arviv, 1999). These minimal solutions were usually of a local nature, established and utilized by a single municipality, and as a result of insufficient maintenance and eventually overload conditions they produced very low-quality effluents.

[☆]The paper is based on a Ph.D. Dissertation conducted in 2000–2003. The dissertation was conducted by the corresponding author and supervised by the co-author.

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This state of affairs was a result of several integrated factors: local authorities that neglected the issue and did not allocate sufficient resources towards its solution (The State Comptroller, 1972); Central Government that regarded wastewater treatment as a low priority, resulting in an inefficient financial and institutional national framework; lack of public environmental awareness and pressure; a strong agricultural lobby that was very influential in the water sector and regarded the effluents as a free, additional water source for the farmers and agricultural community (Adam, 2000). Thus, by the beginning of the 1990s, over 20% of the wastewater generated in Israel was dumped untreated into the environment, whereas the rest was mostly insufficiently treated (Gabbay, 1992).

The 1990s, however, were characterized by the initiation of many advanced intensive Wastewater Treatment Plants (WWTP) by local authorities (Gabbay, 2002). Intensive technologies are high-tech advanced treatment processes, based on the principle of operating on a reduced surface area and intensifying the natural processes of dissolution by technological means (Arviv, 1999). This was mainly the result of a change in the Central Government's policy and growing environmental public awareness and pressure. As opposed to the local extensive solutions of the previous decades, many of these intensive projects were regional schemes based on a central WWTP, which serves few neighboring municipalities. This paper presents and discusses two case studies of such regional cooperation.

2. Background and context

Israel is burdened by a serious shortage of fresh water that will grow worse in the coming decades due to population and economic growth. With limited water potential on one hand (~300 CM per capita per annum) (Gabbay, 1992) and ever growing water demand on the other, there is constant pressure on the water sources—as all feasible resources are exploited, thus creating an urgent need to protect them (Gabbay, 2002).

Thus, treating wastewater is obligatory for two main reasons:

- (a) Untreated or partially treated wastewater creates health and environmental hazards, mainly pollution of fresh water resources, particularly riverbeds. This is the case especially in regions which suffer from water shortage, as water resources are exploited to the maximum capacity and even beyond, resulting in smaller water bodies and short retention times, generally accompanied by deterioration of water quality by pollution (Friedler, 2001). Indeed, in Israel, untreated or partially treated wastewater became a major source of pollution of fresh water resources (Gabbay, 1994).
- (b) The growing demand for water in the domestic sector will mainly affect the agricultural sector, as it will be

countered mainly by reducing water supply for irrigation. The demand for water in agriculture can be supplied by the reuse of treated wastewater, releasing some of the pressure on the potable water resources (Friedler, 2001). Therefore, in Israel treating wastewater is not only a sanitary necessity, but also an additional way to increase water potential.

As aforesaid, although the issue was widely neglected for many years, during the 1990s many local authorities in Israel were engaged in promoting WWTP projects, many of them projects of regional cooperation.

2.1. Regional cooperation for the delivery of public services

One of the Government's major functions is to collect revenues from the citizens and redistribute them through the provision of public goods and services (Massam, 1975). These responsibilities, which were assigned to the local authorities, have expanded in recent years in some countries, as a result of political and fiscal decentralization reforms (Razin, 1998). However, local authorities differ in their abilities to provide services (Massam, 1975).

As a result, sometimes there is a need for inter-municipal or regional cooperation (in this paper these terms will be used synonymously), i.e. cooperation between two or more local authorities with geographic proximity. The term is usually applied to voluntary, formal, written agreements concerning public service provision and mechanism for joint solution of problems, common to more than one jurisdictional unit (Massam, 1975). It is usually created on an *ad hoc* basis, and generally in order to perform one single function (Pinch, 1985; Burns, 1994). The form of the agreement varies considerably and can include an agreement between municipalities to construct and operate a major facility, agreement by which a large municipality sells services to smaller ones, an agreement by which municipalities offer services to each other in cases of emergency and so on (Massam, 1975). Regional cooperation is an efficient tool to address problems that extend beyond municipal boundaries and to ensure the efficiency and high level of the provided service. Its main advantages are: economies of scale, balancing disparities between local authorities and reducing spillover effects.

1. *Economies of scale*: Inter-municipal cooperation is a viable option to create economies of scale for the delivery of public services (Martins, 1995).
2. *Balancing disparities between local authorities*: The political and fiscal decentralization reforms, mentioned above, enhanced the already-existing disparities among local authorities (Razin, 1998). Along with other factors, these disparities influence the local authorities' ability to provide services.
 - *Fiscal strength*: Local authorities differ in their fiscal strength that is influenced by several factors such as:

The socio-economic features of the municipality's residents—residents which rank higher in their socio-economic features pay higher taxes and need fewer welfare services; *Population size*—smaller municipalities are affected by fiscal weakness due to high per capita cost and low rate of self income; *Location in the center or in the periphery of Israel*—municipalities located in central Israel are stronger, among other things, due to their ability to collect taxes from non-residential land-uses which figure highly in the municipality income (Razin, 1998).

- *Political power*: Small, weak, peripheral and minority municipalities may be affected by political weakness (Razin, 1998).
 - *Human and technical resources*: Very small municipalities cannot command the human, technical and administrative resources which are needed for the management of complex projects (Martins, 1995).
3. *Reducing spillover effects*: Very often, due to geographic proximity of neighboring local authorities and due to population mobility, services and facilities which are provided and paid for by the residents of one municipality may be utilized by residents of nearby municipalities (Massam, 1975). Conversely, certain activities may create negative side effects in nearby governmental units, such as in the case of air pollution from an industrial area, which circulates and is transported to other neighboring areas. These effects are known as “spillover effects” (Pinch, 1985). In these cases, regional cooperation can reduce the spillover effect by distributing costs evenly and reducing negative side effects.

2.2. Regional cooperation for wastewater treatment

Regional cooperation for wastewater treatment is common in North America, often in the form of “Special Districts”. Special Districts are independent local units of Governments that are formed in order to provide services, and generally perform only one single Local Government function. The reasons for their formation are relevant to this discussion. For example, they compensate for inefficient Local Governments; their formation is expedient; and they have financial advantages due to a variety of revenue sources. They have territorial boundaries but geographic flexibility as they can overlap other government units. Special Districts for sanitary services, within which regional WWTPs are operated, are very common in the USA (Central Contra Costa Sanitary District, Muskegon County Wastewater Management System, Sacramento Regional County Sanitation District, and many others), where such government units have a long tradition. Thus, some were formed at the beginning of the twentieth century, for example the drainage districts in Texas and the water districts in California (Burns, 1994). Regional solutions are common also in Canada. For

example, in Victoria, the capital of the province of British Columbia, sewage disposal has been assigned to a regional authority (Ellis, 1989).

In Europe, regional cooperation for wastewater treatment can also be found. In France, for example, municipalities commonly establish joint-ventures to carry out the task of wastewater management. In Germany, wastewater management is the responsibility of the municipalities. If they are too small to address the financial and technical complexity of this task, they form an inter-municipal joint-venture (WHO/UNEP, 1997). Similar trends can be found in other countries such as Austria and Finland, where priority is given, on local and provincial level, to combining flows from many small communities into regional plants. The reason for this is to secure the necessary level of management and scientific control, as in many countries small-sized plants were considered as having management and maintenance problems due to employing local, poor-quality personnel and diseconomies of scale. In accordance, advantages of the regional WWTP, which have been mentioned, include better treatment efficiency and higher qualifications of WWTP operators. They also include lower costs of planning, construction, maintenance and operation (United Nations, 1984). Indeed, supporters of the regional approach note that planning WWTP on the basis of the administrative boundaries of small municipalities rarely makes sense, and that regional cooperation creates major financial gains (UNEP/GPA, 2000).

Nevertheless, disadvantages are also reported and should be noted: difficulty in allocating respective costs to users, greater vulnerability in case of failure, and higher costs of sewerage lines and pumping stations (United Nations, 1984). It is noted that despite clear examples of economies of scale in wastewater infrastructure, these are balanced by the increasing cost of transporting the sewage over long distances (UNEP/GPA, 2000). Accordingly, some scholars suggest that the regional approach, although the preferred choice of planners and decision-makers cannot always be considered as the preferred alternative. It should be weighed in comparison to other alternatives, such as smaller facilities serving individual towns, or decentralized solutions on different scales, to choose the most feasible on a case-to-case basis. Bakir (2001), for example, presents the case of wastewater treatment for small towns in Middle East and Northern African countries. In several countries (e.g. in Jordan and Egypt) transporting wastewater from several scattered communities to a centralized WWTP, became a trend. Bakir argues that this approach is inappropriate due to large usage of fresh water needed to transport the waste—a scarce commodity in this region, and due to the high costs. Costs of network (conventional sewers) can account for 80% of the total capital cost of the collection and treatment facility (Otis, 1996) and is regarded as one of the major constraints to

expanding wastewater services. Cost of network becomes even higher when provided to sparsely populated small communities (Bakir, 2001).

As aforesaid, in Israel, the shift in the Central Government's policy with regard to wastewater treatment, which occurred in the beginning of the 1990s and will be discussed later, also marked a shift towards a regional approach, as this was preferred by the Government and by many local municipalities. Thus, over 90% of the new projects were inter-municipal, serving two or more neighboring municipalities. This paper reviews the shift from local to regional approach with regard to wastewater treatment in Israel and discusses advantages and potential problems of regional cooperation for the establishment of a WWTP by presenting two case studies.

3. Methodology

In addition to the general characteristics and trends of wastewater treatment in Israel over the years, this paper presents two case studies: the regional WWTP of Karmiel and the regional WWTP of Hadera. These case studies were selected as they are typical of the general trends of regional cooperation for wastewater treatment in the 1990s, yet differ in factors such as geographic site and location (center versus periphery, topographic features), ethnic composition, type of organization, etc.

Documents' review and interviews were used to collect data. In each of the case studies documents such as correspondence, protocols and plans were collected and analyzed. Interviews were held with people in the studied local authorities who were involved in the regional WWTP; government officials who were involved in such projects; private consultants to the local authorities (sewage engineers, economists, lawyers, etc.); personnel in non-government public institutions; environmental NGO's; experts from the academy; and others with relevance to the case studies and the general patterns of wastewater treatment. All these interviews were conducted as part of an effort to present the "broader picture" regarding the characteristics, problems and historical development of WWTP's.

Data regarding size and socio-economic features of the local authorities (Tables 3 and 4) were obtained from the formal publications of the Central Bureau of Statistics (CBS) in Israel. The CBS characterizes and ranks all local authorities in Israel according to the socio-economic features of their population. Based on a series of characteristics, the local authorities were clustered into 10 groups: cluster 1 represents the lowest socio-economic level ranking, and cluster 10 represents the highest socio-economic level ranking. This ranking system is used in this paper to sort out the socio-economic features of the local authorities.

4. Findings

4.1. Wastewater treatment in Israel—from local to regional approach

4.1.1. First stage: the local-minimal approach, 1950s until the end of 1980s

Until the end of the 1980s, except for the metropolitan areas of Haifa and Tel Aviv, most of the urban settlements settled for minimal local wastewater solutions, mainly constructing extensive facilities.

Rapid population expansion and urbanization in the first decades of the state resulted in the fact that treatment facilities and proper sanitary disposal lagged behind the development of sewerage systems (Shuval, 1971). In those years municipalities were looking for the cheapest solutions for sewage treatment and very often the most convenient solution was found in agricultural reuse. The solutions that evolved were always on a small scale, with minimal treatment, short transport distances and little or no intervention from health authorities (Selbst, 1980).

Thus, the "traditional" model that evolved was that of local nature, a "symbiosis" between an urban municipality in a rural setting and its immediate agricultural hinterland, usually a neighboring agricultural settlement. According to that model, the urban municipality established extensive treatment facilities such as oxidation ponds, usually situated in the agricultural area near the consumers and as far as possible from the urban inhabitants. The farmers, on their part, invested in reservoirs and used the (very low quality) effluents for irrigation.

These solutions suited the different interests of urban and rural communities very well, and thus were accepted by all the parties involved. The general position standing of this era can be briefly summarized as follows: wastewater treatment was not a high priority for the Central Government which, therefore, was not interested in allocating large budgets for that purpose. On the other hand, the water sector was dominated by the agricultural sector; the latter's position was very strong and influential, as set out below; The local authorities, often facing financial difficulties, were not interested in investing vast sums of money in wastewater treatment as the public was indifferent to environmental issues and as investment in wastewater treatment, on the outskirts of the city, was considered an investment without any local political appeal. Many local leaders lacked environmental consciousness and settled for solutions that simply removed the wastewater from their jurisdiction and gave little thought to the treatment and disposal factors; the farmers received free or very cheap additional sources of water to be used as they saw fit. All these factors led to the local-minimal solutions that characterized wastewater treatment in urban settlements at that period.

However, the low-quality effluents were used by farmers only when needed, and in the rainy, otherwise non-irrigation season surplus effluents were dumped into the

nearest stream or dry riverbeds. Moreover, these simple facilities soon became a hazard source themselves due to insufficient maintenance. As the cities grew and the flow of wastewater increased, the quality of the effluents decreased due to overloading, and partially treated wastewater was discharged into the environment. In some cases, the urban municipalities did not establish even these minimal solutions, and in fact discharged untreated wastewater into the nearest stream (e.g. Jerusalem) or to the Mediterranean (e.g. Acre and Nahariyya).

As a result, by the end of the 1980s wastewater was mostly insufficiently treated or not treated at all. Almost all the country's flowing streams and dry riverbeds carried heavy flows of wastewater and the few larger perennial streams were anaerobic for major portions of the year, losing their role as a natural resource for leisure, recreation and open-area amidst the dense urban areas. Wastewater became a major source of pollution to the environment, the groundwater and the landscape and caused nuisances such as odors, mosquitoes and health hazards (Shuval, 1980; Adam, 2000). Despite all this, and with an indifferent Central Government, most local authorities ignored the bleak situation and did nothing to try and find a solution for the problem.

4.1.2. *Second stage: a shift towards a regional approach*

The beginning of the 1990s, were characterized by a change in the "paradigm" of the Central Government's policy towards the wastewater treatment: The Ministry of Environment was established in 1989. It was the first Government agency responsible only for protecting the environment, and it has become a very important actor with regard to wastewater treatment (Adam, 2000); Regulations for baseline level requirements of effluent quality (20 ml/l BOD 30 ml/l TSS) were promulgated for the first time in 1992, obligating every settlement with 10,000 or more inhabitants to conform (Gabbay, 2002); relevant laws were enforced for the first time since the foundation of the state. Mayors were indicted or threatened with indictments, governmental agencies refused to permit municipalities to populate newly built neighborhoods unless they had planned or functioning WWTP, etc. These measures put enormous pressure on the Local Government to take action (Gabbay, 1994; Adam, 2000); The budget for wastewater infrastructure was significantly increased from 15 to 20 million New Israeli Sheqel (NIS) a year prior to 1992, to 180 million NIS in 1993, 250 million in 1994, 450 million in 1995, etc.

These measures and others all meant that the Central Government had changed its policy and made it clear that the current situation was no longer acceptable. The Local Government responded accordingly and started promoting wastewater solutions.

The new regulations regarding high-quality effluents; the sufficient budget, allocated for this purpose; the bitter past experience with extensive solutions which did not provide high-quality effluents and became a hazard source; and the

fact that at this point of time extensive solutions, which require vast areas, were no longer considered a realistic alternative in the densely settled country, lead to a process in which the new WWTPs that were promoted by the local authorities during the 1990s had to be, in most of the cases, advanced intensive facilities. This trend was advocated by the Central Government and in fact other solutions would have not been approved by the authorities. As these were complex projects that required not only high investment but also adequate personnel capacity and capable local leaders, many local authorities as well as the Central Government, preferred to promote regional-based WWTPs.

4.2. *Case studies of regional cooperation*

The two case studies presented in this paper are both cases of regional cooperation for the establishment of a regional WWTP. Although these case studies differ in many factors: geographic site and location (center versus periphery, topographic features), ethnic composition, type of organization, etc., they are typical of the general trends of regional cooperation for that purpose in the 1990s.

4.2.1. *The Karmiel Region Union of Towns for Sewage Treatment*

"The Karmiel Region Union of Towns for Sewage Treatment" is a regional cooperation of local authorities that are located on the hilly part of Hilazon stream drainage basin, a peripheral area in Northern Israel, in the Lower Galilee. The member municipalities in the cooperation are Karmiel, the Regional Council Misgav and the Arab municipalities Nahaf, Ba'ane, Sajour, Sha'ab, Dir el Asad, and Magedal Krum. Total population served by the plant today is about 120,000 people (about 50,000 Jewish inhabitants and 70,000 Arab inhabitants). The plant was developed during 1990–1999.

The Hilazon stream flows west from the hilly western lower Galilee, tributary to the Na'aman stream (drainage basin's area 317 km²)—which outfalls to the Mediterranean near the coastal city of Acre. For years, the ephemeral stream was polluted by untreated wastewater from Karmiel—the largest municipality in the drainage basin, as well as from the other local authorities in the basin. Karmiel's wastewater was conveyed into a reservoir in a nearby agricultural settlement located in Misgav R.C., which used the effluents for irrigation of cotton. However, as the city grew, the reservoir was overloaded and untreated wastewater overflowed into the adjacent dry riverbed. Most of the Arab municipalities in the basin suffered from undeveloped sewage infrastructure that resulted in wastewater flowing to the streets and downhill from over-filled septic tanks. Some of them, such as Sahnin, Arabe' and Dir Hana discharged untreated wastewater into the dry riverbed. The on-going situation caused environmental and health hazards: bad odors and swarms of mosquitoes—especially in settlements downstream such

as Sha'ab. Local water wells were contaminated to the extent that the Health Ministry, on several occasions, had to order local inhabitants to boil drinking water. Despite all this, local leaders ignored the situation and had no plans to solve the problem due to lack of public pressure, lack of local leaders' interests and financial difficulties.

In the beginning of the 1990s the Central Government, seeking to find a solution for the problem, started to put pressure on Karmiel to treat its sewage. The Government's pressure was applied in the following ways: refusing to populate new neighborhoods unless a sewage solution was found; not issuing business licenses to new plants/factories, etc. in a new industrial area; and, finally, threatening the Mayor with legal action. All these measures brought the Mayor of Karmiel to the realization that he must find a solution to this problem.

Simultaneously, the Central Government started to promote the idea of a regional WWTP, realizing that a regional approach was needed to solve the over-all problem of sewage pollution in the drainage basin, to rehabilitate the natural surrounding and protect the local groundwater resources. Karmiel went along with the regional approach realizing its advantages, whereas the Arab local authorities in the basin were less cooperative and had to be convinced by the Central Government to join the project. When it came to the Arab local authorities, the Government chose to take a different approach. Most of these local authorities are smaller than 10,000 inhabitants, which mean that they are not required by state regulations to treat wastewater up to a secondary level. In addition, all these Arab local authorities are of a very low socio-economic ranking, and face many other problems. Realizing this, the Government negotiated with these local authorities, explained the benefits of the project, and financed the construction of the sewage collection infrastructure in those towns in order to enable them to be connected to the plant. They were not very enthusiastic, mainly due to the costs required, and in fact preparations for the construction of the plant began before it was clear which local authorities would cooperate. Eventually most of them joined the project. Some of them, however: Sahnin, Arabe' and Dir Hana, decided to find a separate cheaper solution as the regional intensive project was too expensive for them. In 2001, after no progress was made in advancing their separate plan, they joined the regional WWTP. They joined under the status of service-receivers, i.e. non-member municipalities in the regional body, which buy services from it. In order to encourage them to join the plant, they were charged the same per CM as member municipalities.

The local authorities formed a "Union of Towns"—a local authority (similar to special districts) formed by neighboring local authorities that cooperate in order to establish a joint project or provide a joint service. This body manages a separate annual budget, which is provided by the Ministry of Interior, and it has authority to promulgate bylaws ([Union of Towns Law, 1955](#)). However, it is interesting to note that Karmiel's leadership was

the active actor in the process of decision making and in fact promoted the project, negotiated with the relevant parties, coped with all the local problems and became the lead partner, whereas the rest of the local authorities were very passive, by choice.

Locating the plant in the hilly landscape is technically more complicated. As a regional plant, however, the facilities needed to be located downstream. The regional approach—based on a drainage basin, provided these location alternatives and eventually the plant was situated in the jurisdiction of Sha'ab. In 1999 the intensive plant—based on activated sludge technology, went into operation, producing high-quality effluent (10 mg/l BOD/15 mg/l TSS).

This case demonstrates one type of a regional-cooperation model. According to it, the stronger municipality promotes the project, negotiates with the Central Government and with other potential partners while the rest can be passive participants. This model insures that all the local authorities in the project, including those less enthusiastic and less capable, treat their wastewater to a high standard. As the project is based on the unity of one drainage basin, it also promotes the rehabilitation of the stream to the benefit of all the local people.

Some problems should be pointed out: (1) despite long negotiations with Sahnin, Arabe' and Dir Hana these municipalities chose not to join the erected plant and only joined it two years after it went into operation. During these years untreated wastewater was still being discharged to the riverbed; (2) some of the members do not pay the regional body for their wastewater treatment. As the Union does not have the means to obligate them to do so, it may face severe financial problems if this trend continues. Karmiel, the lead partner, does not have the means to cope with this problem on its own and the Central Government does not address the problem; (3) there is no near-by market for the effluents, and the Union does not have the means to invest in long effluent conduits. Therefore, at the moment the effluent is not being reused. This issue is of great importance in this water-scarce country.

4.2.2. *The Regional WWTP of the "Treatment and Reuse of Wastewater in the area of the Hadera Stream, Ltd." Corporation*

This case is a regional cooperation of neighboring urban settlements situated in the lower parts of the Hadera and Taninim drainage basins, the central coastal area of Israel. The members are: Hadera, Pardess Hana-Karkur, Biniamina, Or Akiva, Giv'at Ada, Jiser-a-Zarka and the "Caesarea Edmond Benjamin de Rothschild Development Corporation Ltd." (the only residential area in Israel that is not a local authority). All of those, except for Jiser-a-Zarka, are Jewish local authorities. Total population: about 113,000. This project was developed during 1988–1996.

Both the Taninim stream (drainage basin area—183 km², length 25 km) and the Hadera stream (drainage basin

area—610 km², length 60 km) flow west from the Menashe' hills to the Mediterranean, mainly flowing in the coastal plain of Israel. Prior to the establishment of the WWTP, the wastewater treatment situation in the area was bleak. Hadera, the largest and most industrialized municipality in the region, had a dysfunctional treatment plant that discharged very low-quality effluents to the Hadera stream and caused many hazards to the city residents. In the rest of the local authorities, wastewater was discharged untreated to the nearest stream or dry riverbed, or to septic tanks. As a result, many environmental hazards were caused: the area's streams—especially Hadera stream, were heavily polluted and thus caused health hazards and lost their role for recreational purposes, and the local groundwater resources were contaminated. However, the reasons for the decision to promote a WWTP were several poliomyelitis cases discovered in Or Akiva in 1988, which caused public panic. The Health Minister at the time accused the local leaders in the area for failing to treat wastewater and as a result, being responsible for the outbreak of the disease. Although an investigation revealed later on that this was not the cause, wastewater treatment has already become a conspicuous political issue and a high priority for the local leaders as a result of public pressure, and they have decided to take action.

Contrary to the former case, the regional approach in this area was decided and agreed by the local leaders when they met in an emergency meeting after the polio outbreak, acknowledging the need for a regional solution. This meeting took place within the framework of an existing regional union the authorities belonged to: the "Regional Union of Towns for the Protection of the Environment" that was established in 1980 to monitor air pollution from the near-by power plant. When a decision was made in 1988 to find a solution to the wastewater problem, it was inevitable that the local authorities should take joint action through the existing Union, which agreed to carry-out the task of preparing a regional plan for sewage treatment. The existence and success of this environmental regional Union, as well as the positive experience of the local authorities with the joint action, no doubt, contributed to promoting the regional approach.

The plan, which was presented by the Union, found that the drainage basin of Taninim stream is less populated and has fewer sources of pollution than the Hadera stream. Therefore, it was decided that wastewater from settlements in the Taninim basin would be transferred to the Hadera basin where the regional WWTP will be situated (on the site of Hadera's existing dysfunctional WWTP), allowing the Taninim stream a better chance of rehabilitation. This principle gave an additional value to regional cooperation. The plan was accepted by all the local leaders and they presented it to the Central Government in a request for financial aid. Although initially the Central Government did not approve of the plan, eventually, as part of its 1990s shift of policy, in 1990 the Central Government gave the plan the required approval.

Although, the local authorities preferred to integrate the regional treatment plan within the framework of the existing Union, the Ministry of Interior instructed them to establish a corporation as a part of the new Governmental policy to shift infrastructure management from the public sector to business corporations. The corporation published an international tender for a Turn Key project to establish and operate the plant and received a long-term loan from the Government for that purpose.

In contrast to the former case, all local leaders were active in the decision making process and decisions were made jointly by all members of the venture. In 1996, the intensive plant—based on activated sludge technology, went into operation, producing very high-quality effluent (5 mg/l BOD/5 mg/l TSS).

This case demonstrates a second type of model in which all or most of the local authorities initiate the project and promote it together as a group of equal decision makers.

Similarly to the previous case, some problems arose and should be pointed out: (1) although most of the local leaders were fully committed to the project, the Mayor of Or Akiva insisted for a long time on getting special grants for its share of the project from the Government, based on the city's low socio-economic status. Until 1999, he refused to connect to the plant. This caused a major problem as the rest of the settlements in the Taninim basin were planned to be connected via Or Akiva, and thus were not able to hook up to the plant as well; (2) as in the Karmiel case, some of the members do not pay their share. This causes major financial problems for the corporation and the matter is being arbitrated; (3) the corporation, that needs to generate income to cover its high costs, wants to sell the effluent for reuse purposes to the nearby regional council. Despite its high quality, disagreement over the price causes the effluent to be discharged to the Hadera stream instead of being reused.

5. Discussion

5.1. Advantages of regional cooperation for wastewater treatment in Israel

Israel is characterized by a relatively high number of settlements: 219 urban settlements (cities, local councils) and 54 regional councils (comprised of ca. 900 rural settlements) in 2004. Most of the urban settlements are small, 196 of them smaller than 50,000 inhabitants. In addition, most of the settlements are concentrated in one-third of the country, as two-thirds are arid. Thus, there is high density of settlements and as a result settlements are situated in proximity to one another and distances between them are not long (Central Bureau of Statistics, 2005, Table 2.12).

As many of the local authorities are relatively small (median size: 7500 inhabitants), it also means that the ability of many of them to support complex projects and to bear the costs of infrastructure development—is limited

(Ben Eliah, 1998). Moreover, in contrast to many European countries that have developed a regional and provincial level of government that expands the range of functions carried out by sub-national level and can compensate for the extremely fragmented Local Government system by a strong regional administration that takes over the responsibilities for services that cannot be supplied by small municipalities, Israel's Local Government system is largely a single-tier system composed only of cities, local councils and regional councils (Page and Goldsmith, 1995; Razin, 1998).

Whereas municipalities can confederate by law to create "Union of Towns", these regional bodies were generally used to undertake functions within metropolitan areas and were little used in other areas (Elazar, 1988). In addition, up to the 1990s, except for the metropolitan areas of Haifa and Tel Aviv, regional cooperation for wastewater treatment did not exist, as wastewater treatment was minimal and of local scale, therefore a regional approach was not needed. Since the 1990s, however, many projects of regional WWTP were established in Israel as population size and density and requirements for high level of treatment, made such solutions necessary.

The case studies presented in this paper differ in several variables and characteristics, as presented in Table 1. Nevertheless, the findings suggest that regardless of these differences, both cases demonstrate some advantages for regional cooperation between urban settlements for the establishment of a WWTP. The main advantages are:

1. *Reducing spillover effects:* Wastewater is a running infrastructure and as such, pollution caused by it does not recognize political boundaries. The long-term neglect of wastewater treatment, by most of the municipalities in Israel throughout the years, caused spillover effects of pollution and nuisances in many areas. A regional cooperation for wastewater treatment can address all sources of pollution and prevent

undesirable situations in which some local authorities have invested in wastewater treatment yet continue to suffer from pollution caused by others. In Karmiel, the regional approach addressed a regional-basin wide problem of inflicting nuisances on downstream settlements and contaminating water wells that were used by all local inhabitants, and provided a holistic solution that enabled the natural environment to be rehabilitated. With Sahnin, Arabe' and Dir Hana finally joining the plant in 2001, the discharge of untreated wastewater into the stream, was stopped. In Hadera, the over-all problem of polluting the streams and the local groundwater affected the whole region, thus requiring a regional approach. In addition, prior to the project, the environmental hazards that were inflicted on a certain settlement were very often typically spillover effects from pollution originating in a neighboring settlement. One of the regional plan's aims was to prevent a situation in which one or few local authorities treat wastewater yet continue to suffer from pollution caused by others. The project also enabled the Tananim stream to be rehabilitated for the benefit of all the inhabitants in the region. It now serves as a nature reserve, which attracts many visitors.

2. *Balancing disparities between local authorities:* In accordance with previous studies, the findings suggest that also in the case of wastewater treatment, a regional cooperation is an efficient mechanism to balance disparities between local authorities, especially as WWTP is a high-cost infrastructure, which requires fiscal strength and human resources capacity.

Fiscal strength, political power and human resources: As noted in Table 2, most of the local authorities in the Karmiel region, except for Karmiel itself and Misgav R.C. are Arab towns characterized by very low socio-economic ranking (the low 2nd and 3rd clusters). They are also relatively small—7 out of 9 with less than 10,000

Table 1
Features of the two case studies: a comparison

	The "Karmiel Region Union of Towns for Sewage Treatment"	The "Treatment and Reuse of Wastewater in the area of the Hadera Stream, Ltd." corporation
Geographic site and location	Peripheral area, hilly landscape	The center of the country, coastal plain
Ethnic composition	The majority of the members are Arab local authorities	The majority of the members are Jewish local authorities
Source of pressure and incentives to form a cooperation	The Central Government—pressure from top combined with positive incentives	Pressure from bottom—Public pressure after the Polio cases
Type of organization	Union of towns	Business corporation
The main decision-makers	The leadership of the largest city in the region—Karmiel	Leaders of all member local authorities, as a group
The dynamics of the formation of the regional body	The regional approach was initiated and presented by an external factor—the Central Government, and the formation of the regional body was more difficult as many local authorities joined the project at a very late stage	The regional approach was the natural course of action for the local authorities and was initiated by them from the initial stage

Table 2
Size and socio-economic features of member local authorities and service-receivers in the Karmiel "Union of Towns"

Local Authority	Population size, 1999 (inhabitants)	Socio-economic features (CBS cluster)
Karmiel—member	33,145	6
Nahaf—member	7152	2
Ba'ane—member	5456	3
Sajour—member	2722	3
Sha'ab—member	4361	2
Dir el Asad—member	6485	3
Majd el Kurum—member	9118	2
Regional Council Misgav—member	14,500	7
Sahnin—receives service	18,365	2
Arabe'—receives service	14,037	2
Dir Hana—receives service	6330	2

Source: CBS (1999).

Table 3
Size and socio-economic features of member local authorities in the Hadera Corporation

Municipality	Population size, 1999 (inhabitants)	Socio-economic features (CBS cluster)
Hadera	60,445	6
Pardes Hana-Karkur	21,900	6
Biniamina	4409	7
Or Akiva	13,426	3
Giv'at Ada	2000	8
Jaser-a-Zarka	7835	1
The Cesarea Development Cooperation	3000	Not a local municipality therefore not ranked by the CBS. However, it is a very prestigious settlement with very wealthy inhabitants

Source: CBS (1999).

inhabitants. In addition, they all are villages, which were urbanized and grew into small towns, thus their rate of non-residential land-uses, are low. Thus, they all face many difficulties but at the same time suffer from the on-going situation of wastewater pollution. The on-site solutions they had, mainly septic tanks, were no longer seen as favorable due to the ongoing pollution they caused. However, none of these towns could have established a centralized advanced WWTP by themselves. These municipalities have meager resources, they do not command the human, technical and administrative capacity, and they are politically too weak to cope with expensive projects such as WWTP. Regional cooperation provided them with a good solution.

Karmiel, a stronger local municipality, is a relatively small city with 33,000 inhabitants. As its neighbors, it would have found it more difficult to establish a high-tech advanced WWTP by itself. It could, however, promote such a project based on the technical and organizational resources available to it, and had the human resources and the political power to do so. Putting all these factors on the table allowed smaller and weaker municipalities to benefit from Karmiel's capacities.

In the Hadera case study the member local authorities all differ from one another. As noted in Table 3, two of the local authorities are weak towns characterized by low socio-economic ranking (the low 1st and 3rd clusters). Another three that are ranked higher on socio-economic ranking are small towns of 2000–5000 inhabitants. These towns would have found it difficult to establish an advanced WWTP independently, and the small ones are not even required to do so by the state regulations. The regional project enables the weak and small towns to treat their wastewater to a high standard, for the benefit of their own inhabitants as well as that of the whole region.

If in the past small and medium sized local authorities could have solved their wastewater problem by establishing

the relatively cheaper extensive facilities, during the 1990s these simple facilities were not acceptable any longer, as they could not secure high-quality effluents. Decentralized treatment was not considered a realistic alternative. First, most of the population was already supplied with sewers. Second, the few existing on-site solutions, mainly septic tanks, were associated with many environmental problems due to poor maintenance and overflows. Thus, such solutions as may be appropriate for small communities were not considered to be a sound alternative by the authorities. Therefore, as intensive treatment was the preferred alternative, regional cooperation was required to a much greater extent.

A regional body has also greater fiscal and political strength and as a separate political entity it can obtain a long-term loan from the Government even if some of the local authorities are already in deficit. It also compensates for a shortage in human and technical capacity in some of the municipalities. Thus, in both cases the regional project enabled the small and weak ones to benefit not only from the strength of other municipalities, but also from the strength of the regional body, which as a separate political entity can promote their interests more efficiently.

Local leaders' consciousness, abilities and willingness to take action: Not less important, the findings suggest that regional cooperation is efficient also with regard to indifferent local leadership. One of the key factors in promoting wastewater solutions is the local leadership. However, some of the local leaders lack the environmental consciousness and the willingness to invest in treating wastewater. In the Karmiel case study, most of the Arab local authorities were not enthusiastic with regard to the project, and except for their agreement to participate, chose to be very passive actors in the decision making process. Including them in the regional project, even as passive actors, enabled them to treat their wastewater to a high standard with minimum input in the process.

3. *Location of the plant*: Locating the WWTP facilities can be a problem especially in a small densely settled country. A regional approach enables the replacement of many small separate facilities—with their NIMBY effects, by one regional facility. In the Karmiel case study, in a hilly landscape, the regional approach provided the needed downstream location alternatives. In the Hadera case study the plant was situated in the location of Hadera's existing plant as this site had already been approved for that land-use. Establishing the new plant as a regional one enabled the rest of the municipalities to treat wastewater in an advanced WWTP without the need to allocate areas for it. It also enabled wastewater from the Taninim basin to be treated outside the basin.
4. *Economies of scale*: A research commissioned by the Israeli Ministry of Environment showed that in wastewater treatment in Israel there is a clear case of economies of scale advantages in constructing, maintaining and operating the facilities (Table 4). Thus, in both cases the regional approach made it possible for the member municipalities to establish a high-cost advanced WWTP at a lower per capita cost. The benefits of the economies of scale were especially substantial in both cases as most of the authorities are relatively small and/or weak (Tables 2 and 3). While it is noted that the networks of sewage collection systems are very costly, in Israel the networks in the cities and towns already existed and in fact continued to the outskirts of the city—towards the nearest stream or riverbed, in accordance with the traditional solutions described above. In most cases the existing network was considered as a main factor in locating the facilities. Thus in the case of Israel, the costs of the network cannot be considered as a main constraint for wastewater treatment.

To summarize potential advantages: whereas the economical benefits of the regional approach may be questionable in many cases due to the high costs of transporting systems, other reported advantages such as reducing spillover effect, balancing disparities between local

authorities—especially the ability and willingness of certain municipalities to take action, and making better use of limited land resources, seem to provide a strong case in favor of the regional approach. This approach, however, is not flawless and cannot be expected to provide the most beneficial solution in all cases.

5.2. Regional approach-related problems

Some problems were identified and should not be overlooked. As municipalities can benefit from each other in a regional approach, they are also bound to each other, and actions taken by one municipality, affect the others. Cases in which partner municipalities do not pay their share are evident in both cases and can jeopardize the important achievements. Disconnecting these municipalities from the plant due to unpaid bills means that all the effort and resources that were put into building the plant and the connecting lines will be lost and the environment will once again be polluted. In addition, in the Hadera case, the refusal of Or Akiva to hook up to the plant meant that other settlements from the Taninim basin could have not treated their wastewater as well, until the dispute was resolved. Findings also show that such *ad hoc* agreements cannot obligate municipalities that choose not to join in. In these cases the regional effort may be jeopardized and achievements may also be diminished. The villages of Sahnin, Arabe' and Dir Hana in the Karmiel case study, which continued to pollute the stream for two more years after the WWTP went into operation and before they joined it, present a good example.

Another problem is related to the effluent reuse. Although in Israel a high rate of wastewater is being reused (64% of generated wastewater), these two cases resulted in high-quality effluent not being reused. In Karmiel, the centralized regional approach resulted in a high volume of effluent. Reusing it requires a large demand, which cannot be found in proximity to the plant. The agricultural area in need is the Zevulun valley, some 20–30 km away. Investing in the conduits to transport the effluents is beyond the municipalities' capabilities or those of the farmers. In Hadera, the agricultural market is near-by, but due to the high investments made by the municipalities, the effluent price they set is higher than the price the farmers were used to. Thus, an agreement cannot be reached. In both cases the interim solution is discharging the effluent to the stream. This can be seen as an argument against regional approach in cases when wastewater reuse is important and can suggest that smaller, more localized, facilities can be more efficient in similar cases. Nevertheless, one can also argue that in a water-scarce country (in which all water resources are exploited) discharging treated effluent to streams can rehabilitate the natural ecological conditions and contribute to the goal of stream rehabilitation. This, however, requires higher quality of effluent thus increasing the treatment cost.

Table 4
Wastewater treatment costs (constructing, operating and maintaining) according to size of facility and level of treatment, \$cent/m³

WWTP size	10,000 m ³ / day	25,000 m ³ / day	50,000 m ³ / day
<i>Treatment level</i>			
Primary	11	8	6
Secondary	32	25	21
Tertiary—filtration and addition of chlorine	41	33	29
Tertiary—nutrient removal	50	41	36
Carbon adsorption	61	51	46
Desalination—RO	96	83	76

Source: Harussi and Hoffman (2000).

Additional potential problems that can be associated with regional approach and are not demonstrated directly by the presented cases were found in another case analyzed in the research. They should also be mentioned in this discussion. The NIMBY syndrome is found to be stronger within host communities in the case of larger facilities. This was found to be so in the facilities of the Tel Aviv metropolitan area, located 17 km south next to the municipality of Rishon LeZion and was the first major NIMBY case in Israel.

It is also worth mentioning again that in cases where the networks are not built, the cost of transporting the waste long distances to the regional WWTP may balance the economies of scale and thus should be calculated as part of the overall cost.

6. Conclusions

The early 1990s mark an important shift with regard to wastewater treatment in Israel as many local authorities, including those that neglected the matter in the past, were engaged with WWTP projects. This shift can be attributed mainly to the Central Government's acknowledgment of the urgent need to improve the situation with regard to wastewater treatment. In contrast to previous decades the Central Government preferred to promote intensive WWTP. This new reality compelled both the local authorities and the Central Government to think differently with regard to wastewater treatment and a shift from local solutions to regional approach took place. Thus, either top-down or bottom-up initiatives, many of the new projects were regional ones.

This paper presents two case studies of regional cooperation between neighboring urban settlements in a rural setting, for the establishment of a WWTP. Despite several differences such as periphery versus center of the country and characteristics of the local population, both cases demonstrate some advantages in promoting regional wastewater solutions that can be summarized as an efficient use of limited resources (financial and land), balancing disparities between local authorities (size, socio-economic features, consciousness and ability of local leaders), and eliminating as many sources of pollution as possible in a given area. These advantages are particularly important in the Israeli case: as most of the municipalities did not have satisfactory solutions for wastewater, many of them polluted the environment, resulting in spillover effects. The regional approach addresses many sources of pollution in a given area. It reduces the likelihood that municipalities that treat wastewater continue to suffer from nuisances inflicted on them by others; in the densely populated and settled country, land resources are not abundant. Establishing regional WWTP is a more efficient use of land resources; as most of the population was provided with sewers and the authorities were not in favor of decentralized solutions due to the poor performance of the few existing ones, the

centralized approach is the standard one. However, as a result of regulations for effluent quality, the high population and settlement density and bitter past experience with extensive solutions, the solutions promoted were intensive WWTPs. As these projects are very complicated and require high investments, many local authorities would have found it difficult to promote and establish them on their own.

In the Israeli single-tier system of Local Government with no regional and provincial Governments to take over some responsibilities from small incapable or inefficient municipalities, voluntary, *ad hoc*-based agreements between local authorities such as the ones described in the presented case studies, can indeed compensate for problems of service supply in general and high standard wastewater treatment, in particular. Considering the factors which influenced the lack of action by local authorities with regard to wastewater treatment in the past, and in some cases also in the present—small size, fiscal difficulties, lack of consciousness and unwillingness to take action, these case studies show that a regional cooperation can be an efficient tool for overcoming such problems. The findings also suggest that the advantages of regional cooperation, as presented in the paper, are viable regardless of differences in factors such as the area, type of organization, initiating bodies, etc. The advantages and achievements of regional approach for wastewater treatment are extremely important in the water-scarce country as they contribute to the elimination of many pollution sources that previously endangered scarce water resources. They also assisted many municipalities in treating wastewater up to a high standard, thus providing the opportunity to reuse high-quality effluent for irrigation or for rehabilitation of streams. It seems that in the Israeli circumstances, such regional cooperation indeed provided general positive results.

However, the cases also show that the regional approach is not flawless and some related problems are evident: member municipalities do not respect agreements they signed; some choose for their own reasons not to join a regional plan in formation when there is a clear need for them to do so; and surprisingly enough, effluent reuse may be found to be more difficult to achieve. To summarize, in the Israeli case the regional approach does seem to provide a good, positive solution for high-level wastewater treatment. Many municipalities would have otherwise faced many difficulties in complying with the new regulations imposed by the state. However, it is not the intention of this paper to suggest that the regional approach is the only viable one, nor that it is beneficial in all cases. Wastewater management strategy should always be considered on a base-to-base case, based on comparison between several alternatives and choosing the most feasible one in local circumstances. It is not suggested that wastewater treatment strategy should develop uncritically towards bigger and more extensive systems.

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