World Bank Analytical and Advisory Assistance (AAA) Program
China: Addressing Water Scarcity
Background Paper No. 3

Water Resources Management in an Arid Environment

The Case of Israel

July 2006

Environment and Social Development
East Asia and Pacific Region
The World Bank

The paper was prepared by Gangyan Zhou and edited by Jeremy Warford with the technical assistance of Xiangping Liu. The paper is one of the international experience background study papers of the World Bank's Analytical and Advisory Assistance (AAA) "China: Addressing Water Scarcity." The study is under the management of Jian Xie of the World Bank's East Asia Environment and Social Sector Unit.

For more information on and other reports of the World Bank AAA Program "China: Addressing Water Scarcity", please contact Dr. Jian XIE, The World Bank, 1818 H Street, NW, Washington D.C, 20433, USA, Fax: 202-522-1666, Email: jxie@worldbank.org; or visit the program website at http://www.worldbank.org/eapenvironment/ChinaWaterAAA

Environment and Social Development Department
East Asia and Pacific Region
The World Bank
Washington, D.C.

July 2006

TABLE OF CONTENTS

CHAPTER 1
INTRODUCTION

Israel is a semi-arid country, and a significant increase in population combined with sustained economic growth now place enormous pressure on the country's scarce water resources. To date however, the Israeli government has been successful in addressing this problem. Rigorous enforcement of policy, institutional and legal measures has been very effective, and in many aspects the country is a worldwide leader in water resource management. This paper therefore reviews Israel's efforts in this area in order to identify lessons that may provide useful insights for developing countries – such as China – whose future economic growth is also threatened by water scarcity.

The rest of the paper is organized as follows. The second section briefly discusses current water resource availability in Israel. Section three discusses the legal framework for water resources management. Section four reviews the role of water resources institutions. Section five summarizes major technical strategies for water resource management. Section six discusses economic instruments such as water tariffs, subsidies, water trading, and private sector participation. Section seven contains concluding remarks.

CHAPTER 2
AVAILABILITY OF WATER RESOURCES

Natural Water Sources

Total annual available fresh water in Israel is 1,800 million cubic meters (MCM), which is less than 300 cubic meters per capita (Jerusalem: State Comptroller, 1990). In 2005, approximately 45% of this was used for municipal (primarily residential) consumption, and 50% for agriculture. About 80% of the water potential is in the north of the country and 20% in the south. Normally, water supply fluctuates from year to year in accordance with the annual rainfall. Groundwater provides 55-70% of the total water supply depending on the prevailing climatic and hydrological conditions.

Israel's main freshwater resources are stored in one lake and two aquifers. Lake Kinneret (the Sea of Galilee) is the largest source of water in the country. The Mountain Aquifer, which is under the central north-south (Carmel) mountain range, is the second main source of water. The third one is the Coastal Aquifer that roughly parallels the coastal plain of the Mediterranean Sea. The lake and aquifers provide about 80% of the country's fresh water. The remaining 20% is stored in other smaller regional resources located in Upper Galilee, Western Galilee, the Beit Shean Valley, the Jordan Valley, the Dead Sea Rift, the Negev and the Arava. The long-term average quantity of replenishable water from major water sources amounts to about 1,800 MCM per year, as shown in Table 1.

Table 1 Long Term Potential of Renewable Water from Major Sources

Source	Replenishable Amount (MCM/year)
The Coastal Aquifer	320
The Mountain Aquifer	370
Lake Kinneret	700
Additional Regional Resources	410
Total	1,800

Source: Ministry of National Infrastructure,

Surface Water – the Kinneret Basin

The Kinneret Basin is in the northeast of Israel and covers 2,730 sq. km. The lake is fed mainly by the Jordan River, whose three tributaries contribute to an average inflow of about 650 MCM/year. The lake of Kinneret has a surface area of about 170 sq. km and a total volume of 4,300 MCM. The water level of the lake is regulated at the Deganya Gates, maintaining an operational volume of 590 MCM, between -209 and -213 meters. Of the annual water storage, about 380 MCM (20 cum/sec) on average is pumped out of the watershed, while the remainder is used by consumers within the watershed.

Underground Water - the Mountain Aquifer

The Mountain Aquifer stretches for 150 km between Taninim in the north and Beer Sheva in the south under the Judea and the Samaria highlands. Natural outlets are the Yarkon and the Taninim springs with a possible outlet to the Mediterranean Sea.

More than 300 deep boreholes are used to pump about 340 MCM/year, including 40 MCM of brackish water, maintaining a water table level at 16.5 meters. Artificial recharge using excess supply from the Kinneret is practiced using single and dual purpose deep wells connected to the National Water Carrier.

Underground Water - the Coastal Aquifer
The Coastal Aquifer has a total area of about 1,800 sq. km and extends over some 120 km along the Mediterranean coast from Carmel in the North to the Gaza Strip in the south. The safe yield, which is fully utilized, is estimated at about 300 MCM/year. A certain level of seawater intrusion is allowed for optimal exploitation of the aquifer. The interface was stabilized at about 1500 meters from the coast. Being a sand aquifer with a large holding capacity, the aquifer is used for short and long-term storage, allowing a normal supply in drought years. However, due to frequent droughts and depletion of reserves endangering the sustainability of the aquifer, artificial recharge has to be intensified, while exploitation has to be carefully monitored.

Underground Water - Other Aquifers
In addition to the two major aquifers, there are several smaller and localized aquifers in various parts of the country. The most significant is the Western Galilee Aquifer, having a safe yield of about 60 MCM/year.

Produced Water Resources

After exploiting nearly all of its available natural water resources and promoting vigorous conservation programs, Israel has long made it a national mission to enlarge water supplies by developing non-conventional water sources. Efforts to do so have focused on the following:

Reclaimed Wastewater Effluents
Treated domestic effluents, estimated at 400 MCM, form the largest potential water source. Currently, about 250 MCM of effluents, treated to varying degrees, are already utilized for irrigation. The rest is discharged into watercourses and the sea due to lack of treatment and reuse facilities. At the end of 1999, an estimated 300 MCM (25%) of the total amount of water supplied for irrigation was in the form of reclaimed sewage effluent. This is expected to increase to about 600 MCM by the year 2020.

Intercepted Runoff and Artificial Recharge
Although surface runoff is sporadic, several regional and local schemes have already been established. The schemes divert storm flow from the rivers into surface reservoirs from which they are pumped into the supply system, or dispersed on spreading grounds and left to percolate into the underground aquifer (mainly along the coastal plain). At present, approximately 40 MCM are intercepted, out of a potential of 135 MCM/year of stormwater. The main intercepting installations operating today are the Kfar Baruch, Dalia, Menashe, Shikma and Bsor rivers. Other small schemes include hundreds of small runoff interception projects amounting to about 130 MCM.

Artificially-Induced Rainfall - Cloud Seeding
Cloud seeding with silver iodide crystals has been practiced in Israel for the last 30 years on a countrywide basis, using ground incinerators and aircraft. Controlled

experiments conducted between 1960 and 1975 pointed to a positive significant effect of seeding in increasing rainfall. It is estimated that a significant increase of 10-15% in rainfall in the northern part of the country has been achieved. Internal and external sources (e.g. the World Meteorological Organization) have cited the Israeli seeding program as one that has statistically been shown as a significant success, although the limited cloud occurrence in drought years limits the benefits of cloud seeding when it is most needed.

Desalination

Israel has many small and medium size desalination plants in operation, these being used to process brackish and seawater for domestic water supply in the Arava Valley and the Gulf of Eilat. The largest of these facilities produces 44,000 cum/day of water from brackish groundwater and seawater, thus meeting most of the drinking water requirements of the town of Eilat. Reverse osmosis has been adopted as the leading technique for brackish and seawater desalination. The first seawater desalination plant, with a capacity of 10,000 cum/day was commissioned in 1997 and other modules of various capacities are planned along the Red Sea and the Mediterranean Sea coast.

Supply and Demand

As of 1998, annual water supply reached approximately 2,100 MCM, of which 75% was potable (natural replenished surface and ground water and desalination) and the remaining was marginal (treated effluents, brackish water and runoff water), as shown in Table 2. Projections to 2020 show the growing importance of treated effluents and desalination. Table 3 shows a trend in which urban uses of water are growing in comparison with the other major category, irrigation, so that by 2020 they will each account for half of total water consumption in Israel.

Table 2. Water Supply by Source 1998-2020 (MCM/year)

Year	Source					
	Surface Water	Ground Water	Brackish	Treated Effluents	Desalination	Total
1998	640	1050	140	260	10	2100
2010 (est)	645	1050	165	470	100	2430
2020 (est)	660	1075	180	565	200	2680

Source: Israel Water Commission, 1998

Table 3. Water Demand 1998-2020 (MCM/year)

Year	Population (million)	Urban Sector	Agricultural and Rural Use, by Source				Total
			Natural	Brackish	Effluents	Total	
1998	6.0	800	920	120	260	1300	2100
2005 (est)		980	750	95	380	1225	2430
2010 (est)	7.4	1060	680	75	490	1245	2680
2020 (est)	8.6	1330	600	60	640	1300	2680

Source: Israel Water Commission, 1998

CHAPTER 3
LEGISLATIVE FRAMEWORK FOR WATER RESOURCE MANAGEMENT

General Responsibilities and Principles

The core of Israel's water management legislation is the Water Law of 1959. The statute has been defined essentially as an "enabling act" that provides the basis for the government to control water demand and charges for the water and related services it provides (Laster, 1976; Laster, 1980). Institutionally, the overall authority for execution of the act is granted to the Minister of Infrastructure (previously Agriculture). A Water Commissioner, as the head of Israel's Water Commission, who reports to the Minister of Infrastructure, is responsible for implementation of the act. The law denies private and riparian rights to water and claims that water resources are a public property subject to control by the State (Water Law, 1959).

The 1959 water law had few provisions that focused on improving water quality. However, the situation changed in 1971 as a comprehensive amendment on water quality expanded section 20A of the law (Tal, 1994). The expanded section states that all water pollution, including all point and nonpoint sources is prohibited.

According to the law, the Water Commissioner has the right to issue a series of orders to reduce pollution problems. One of them requires consumers to restore a water resource to its original state. "Allowing Orders" are the functional equivalent of discharge permits that require submission of sewage plans. The most draconian is the power granted the Commissioner to issue a "Stopping" Order, which literally turns off the taps for anything but drinking water (Water Law, 1971).

The authority to promulgate regulations on water quality, which had been under the charge of the Agricultural Ministry, was transferred in 1989 to the newly established Ministry of Environment. Although there has been a steady stream of new regulations on pollution control promulgated by the Ministry (Tal, 2002), the requirement for broad governmental agreement prior to adoption, as well as the advisory role of a lethargic Water Council dominated by agricultural interests have limited this process.

Besides the laws that control water quality, there are also laws that address other issues related to water resources. Those laws are: the Water Drilling Control Law, the Drainage and Flood Control Law, the Streams and Springs Authorities Law, the Local Authorities Sewage Law, the Public Health Ordinance and the Licensing of Businesses Law. The myriad of legislation, originating from the period of the British Mandate, constitutes a patchwork quilt, which covers the main environmental concerns and hydrological supply matters. However, the past thirty years has seen

little fundamental change in Israel's statutory framework for regulation of water resources.

Box 1 Basic Principles of Israeli Water Legislation

- Water resources are public property and there is no private ownership of water resources;
- Every person has the right to use water for recognized purposes;
- The overall quantity of available water is scarce and a prioritization process has to take place in order to provide sufficient water, in quantity as well as in quality, to all users;
- Only a centralized allocation of water resources can ensure an optimal use of the limited water resources;
- Consumers, through their representatives, need to have a major input in the formation of the rules relating to the allocation of water quotas;
- Attempts must be made to increase the water quantities available for utilization by the consumers;
- Government has the right to take appropriate action to prevent the pollution of water resources

Source: Israel's Water Economy - Thinking of future generations, 10 Aug 2002

Water Law (1959) and Amendments

The Law makes it clear that all water resources belong to the public and are to be allocated to the most urgent and efficient uses only. The law also states that all sources of water in Israel are public property and that every person is entitled to use water, as long as that use does not cause the salination or depletion of the water resource. Therefore, national water planning should follow the principle of maximum water conservation, optimum management of water resources and careful water allocation.

The absence of private ownership of water is further provided for in Section 4 of the Law which states that: "*A person's right in any land does not confer upon him a right in a water resource situated therein or crossing it or abutting thereon;...*"

Contrary to legal concepts prevailing in some other jurisdictions, land ownership in Israel does not include the right to the water flowing through the land, beneath it or drawn from wells situated thereon. Water may be drawn from a well situated on a person's property only in accordance with a water production license, even if the water is intended solely for the landowner's own consumption.

While the Water Law de facto expropriated any private ownership of water and water resources, the right to receive and use water has been "*Every person is entitled to receive and use water, subject to the provisions of this Law*".

The relationship between the public ownership of water and the private right of use is thus established. The right to water is not an absolute one but always applies for one of the purposes recognized by the Water Law. The purposes recognized by the Water Law for private right of water uses are domestic uses, agriculture, industry, handicraft, commerce, services and public services (Section 6).

While the water source itself cannot be subject to private ownership, water production, pumping and supply equipment may be, and is in many cases, privately owned. Thus, once water is allocated the water is brought to the end user through the private sector.

Each and every water use requires a license. This includes well drilling, extraction (production), supplying, consumption, subsurface recharging and water treatment. All licenses are annually issued and, at least de jure, the license granted for one year does not confer upon the recipient the right for a license in the following year although in fact, absent compelling reasons to the contrary, licenses are usually renewed. The license lists conditions that relate to quantities, qualities, procedures and arrangements for production and supply of water, increasing the efficiency of water use, preventing pollution, etc. The license may be revoked by the Water Commissioner if the conditions are not fulfilled or if the water use endangers the water source.

The Law does not prescribe priorities in water allocation though it can be found in the Water Regulations (Water Use in a Rationing Area), which prescribe that in Rationing Areas (geographic areas in which the demand exceeds the supply), water allocation will be in the following order: (a) Domestic Uses; (b) Industrial Uses; (c) Agricultural Uses; (d) Other Uses. Since most of the country has been declared as a Rationing Area the above order of priority is in fact the general order of priority for all water allocation in Israel. The amount of the water allocated in each calendar year is fixed by the Water Commissioner for each of the aforementioned categories. In principle, the allocations are annually adjusted to reflect the changes in water availability and water needs.

Water allocation to domestic users is through the Municipalities. The Municipality serves a dual function, as a consumer of water vis-à-vis the bulk producer/supplier and as a water supplier vis-à-vis all of the consumers within the municipal boundary. Before 1995, domestic uses were subject to quota allocations. Since that year quota allocations for domestic water use were abolished and a strict differential pricing mechanism took its place. The rules concerning municipal supplies require that each consumer must have an individual water meter, and that water is charged for separately and not as part of the municipal levies.

Industrial uses are subject to quotas based on water use tables for the various industrial uses and annexed to the Regulations. There are specific provisions relating to small consumers (i.e. up to 5000-10000 CM per annum). The water is supplied through the Municipalities.

The water allocation system distinguishes between allocations for planned and non-planned communities. Water allocations for planned communities are based on the water needs defined in the agricultural plan for the community. Water allocations for non-planned communities are based on the type of agricultural growth, the growth stage of the plants/trees, and the geographical location of the plants/trees. The allocations are based on water needs in the various regions of the country and normally water will not be allocated to regions where a particular growth pattern is considered to be inefficient.

In 1991 the Water Law was amended with a supplementary chapter on water pollution. The new rules reflect the growing importance that environmental protection

takes in the use of water resources. Article 20 of Chapter Two of the law directly relates to prevention of water pollution. The Article states: "A person shall refrain from any act which directly or indirectly causes, or may cause, immediate or subsequent water pollution; and it shall be immaterial whether or not the water resource was polluted before the act." The law sets fine levels, establishes personal liability, empowers courts to impose cleanup expenses on polluters or to undertake cleanups, and enables citizens to initiate legal proceedings against offenders. The Minister of the Environment is authorized to protect water quality, to prevent water pollution, and to promulgate regulations on these issues. Section 1 of the Water Law lays down the underlying philosophy of Israel's approach to its water resources by providing that:

> "*The water resources of the State are public property; they are subject to the control of the State and are destined for the requirements of its inhabitants and for the development of the country.*"

Other Laws and Regulations

Water Measurement Law (1955)
A fundamental provision in the law is the obligation to provide a measured amount of water to each consumer. Payment for water used is based on water meter readings.

The law grants the Water Commissioner the right to prohibit the supply and consumption of water if a water meter is not installed, and to install a water meter on the account of whosoever was obliged to install one.

Water Drilling (Control) Law (1955)
The law aims to preserve subsurface water sources and prevent water pollution, depletion or salination due to over-exploitation. The law requires the parties to obtain a license from the Water Commissioner for every drilling of a well or every change within a well. In the case of well-drilling or changing a well without a license, the Water Commissioner may order the parties to stop the installation and restore the sites to their original state. A drilling license is required even if the well is designed for personal consumption only.

Local Authorities (Sewerage) Law (1962)
This law clarifies the rights and duties of local authorities in the designation, construction and maintenance of sewerage systems. It requires a local authority to maintain its sewerage system in proper condition. New sewerage systems must be approved by regional planning commissions and by health and environmental authorities. The law also sets out sewerage system charges and fees.

Streams and Springs Authorities Law, 1965
This law empowers the Minister of the Environment, after consultation with local authorities and the Minister of the Interior, to establish an authority for a particular river, spring or any other water source. Those authorities take steps to protect and conserve the stream and its banks, to abate nuisances and prevent pollution.

Prevention of Water Pollution (Rinsing of Containers for Spraying) Regulations, 1991
The regulations prohibit anyone from emptying or rinsing chemical and/or biological substances or their residues from sprayers, collection tanks or any other

installations into a water source, either directly or indirectly. They set specific requirements on the siting, construction and operation of rinsing installations. Specifications are set forth on size, sealing, operation and maintenance of the reinstated collection tanks and evaporation ponds.

Prevention of Water Pollution (Spraying Near Water Sources) Regulations, 1991

The regulations prohibit aerial spraying of biological and/or chemical substances for agricultural purposes near a water source, including Lake Kinneret (Sea of Galilee), the open sections of the National Water Carrier, the Upper Jordan River and its tributaries, streams in the Kinneret drainage basin and other water sources used for drinking water. The regulations set limits on aerial spraying according to wind velocity and wind direction. Spraying from an airplane within 300 meters of a water source, or within 200 meters of certain specified rivers or within 50 meters of any other river is prohibited.

Prevention of Water Pollution (pH Values of Industrial Sewage) Regulations, 2003

Promulgated in November 2003 and coming into effect in May 2004, the regulations aim to eliminate water pollution from corrosion generated by industrial sewage through establishing pH values. The regulations prohibit an industrial plant from discharging sewage with pH value below 6.0 or above 10.0 to the sewerage system, or with pH below 6.0 or above 9.0 to a reservoir, with some exceptions for specific cases.

Prevention of Water Pollution (Usage of Sludge) Regulations, 2004

These regulations, prepared by the Ministry of the Environment in collaboration with the Ministry of Health and the Water Council, aim to prevent water pollution and environmental degradation caused by improper disposal of sludge from municipal sewage treatment plants. The regulations, which came into effect at the beginning of 2005, require wastewater treatment plants to stabilize and treat the sludge they generate to be suitable for agricultural use and avoid soil deterioration. The regulations establish maximum limits for heavy metal and pathogen concentrations and odor limits on sludge designated for agricultural use, set recording and laboratory testing requirements, define specific uses for different classes of sludge (A and B), set limitations on areas of sludge use, and prescribe requirements for warning signs, transport and storage. Requirements for class A sludge, which is virtually pasteurized and highly stabilized, will come into force three years after the regulations come into force. Following are the maximum permitted values for heavy metal concentrations in treated sludge (in mg/kg of dry material): cadmium 20, copper 600, nickel 90, lead 200, zinc 2500, mercury 5, and chromium 400.

CHAPTER 4
ORGANIZATIONAL STRUCTURE FOR WATER RESOURCES MANAGEMENT

Institutional arrangements for water resource management have much to do with the management and decision-making culture. In Israel, the agency that is officially in charge of water policy-making is the Ministry of Infrastructure, although this responsibility has historically rested largely with the Ministry of Agriculture, which continues to play an important role, along with other agencies such as the Ministries of Finance, Environment, Health, Infrastructure, Interior, Foreign Affairs, Defense, Trade and Industry, and Tourism Responsibility for managing water systems lies with the Water Commissioner, who sets the rules for water allocations. Mekorot is the company that responsible for allocating available water to consumers. Consumers are represented by a Water Council. The Prime Minister is also involved in national and security decisions directly or indirectly related to water due to the extreme sensitivity of this issue.

Decision-making and management in the arena of water resources are impacted by many factors which ultimately determine the allocation of those resources. Management is greatly influenced by special interest groups, which can impose pressure on the government. For example, in principle the first priority for water allocation is domestic consumption, then industry and only after that, agriculture. However, in practice, priorities tend to be, first, agricultural consumption, then domestic consumption and finally industrial consumption. Moreover, the ministries and entities that make and implement policy are themselves special interest groups, while other private and community interest groups also play an important role.

The State Government

Responsibilities of agencies at State level are briefly summarized below.

Ministry of Infrastructure
The Minister of Infrastructure is in charge of implementing the Water Law (1959), and other basic water resource management legislation. In order to implement these laws, the minister promulgates secondary legislation such as: rules on the width and area of protective strips around water resources, approving orders by the Water Commissioner to reduce water diversion from a depleted water resource and determining norms for the usage of water, its quantity, quality, price, and terms of supply.

By virtue of these powers, the Minister of Infrastructure has established norms for the use of water in fish farms, gardens, industrial plants, fish stores, chicken coops and swimming pools. The minister regulates the supply and demand of water in a certain area and sets maximum water consumption levels and priorities. It empowers corporations to act as water authorities to plan, establish and operate water factories, and is authorized to take

measures against water authorities that do not carry out their functions. The minister can even appoint water institutions such as the Committee for Water Planning and Consumer Representation.

Box 2 The Water Commissioner

Operating within the Ministry of Infrastructure is the office of the Water Commissioner, who is responsible for designing and implementing the policies of the Minister of Infrastructure and responding to all events, including conflicts and disputes that are related to water management and allocation. The mandate of the Water Commissioner is comprehensive, namely management of the nation's water resources to ensure a reliable water supply to all of Israel's residents for their domestic, industrial, agricultural and other uses. The Water Commissioner is therefore responsible for formulating water policies, preventing water pollution, regulating streams and flood prevention, utilizing overflow water, exploiting new water sources, and promoting efficient water use. In particular, water in Israel may only be extracted under a license issued by the Commissioner.

Source: Goldman, M D.,Managing the Water Systems – the Legal Framework in Israel (Jerusalem: The Florsheimer Institute for Policy Studies, 1996).

Through its authority to establish rules for calculating water fees, the Minister of Infrastructure sets water rates for the local authorities, including Eilat, and the rates for water supplied by Mekorot. Under the Drainage and Flood Prevention Law (1957), the Minister has the right to determine which areas will be drainage areas and the need to establish a drainage authority. Under the Local Authorities Law (Sewage) (1962), the Minister's approval is required for any plan to establish a purification and sewage removal facility outside the limits of the local authority establishing this facility (Goldman, 1996).

Ministry of Agriculture

The Ministry of Agriculture represents the largest water consumer group, namely the farmers (Soffer, 2002). This representation typically involves a conflict of interest since water, which belongs to the entire population, is also a tool used by the Ministry to satisfy the interests of the farmers. The Minister of Agriculture's top priority is to supply farmers with largest possible amount of water at the lowest possible price. The Ministry has historically held many of the responsibilities for water resource management that are now under the control of the Ministry of Environment. In view of the political importance of the agricultural sector, on whose behalf it is an advocate, it continues to play a central role in key decisions such as the intersectoral allocation of water and other water management and policy issues.

Ministry of Finance

The Ministry of Finance is responsible for the overall budget and for disbursement to the various entities involved in water resource management. For years, representatives of this ministry have been opposing the establishment of desalination facilities and instead support a policy of raising water prices for farmers as a means of saving water and making effective use thereof (Zaslavsky, 2001).

Ministry of the Environment

The Ministry of Environment is responsible for preventing water pollution. The ministry is authorized to promulgate regulations, prohibitions and restrictions on the location and establishment of polluting

facilities; use of certain materials or production process methods, including agricultural cultivation, fertilization and spraying; production; importation; distribution and marketing of materials and products; regulation of vehicular traffic over and near water resources; and determining the quality of water required for various purposes including the quality of floodwater and sewage. By virtue of this authority, the Minister of the Environment has promulgated regulations that almost completely prohibit the use of cesspools and septic tanks, regulations that limit the use of salt in factory freshening processes, and regulations which prohibit, among other things, spraying and dumping and rinsing methods in spraying facilities which are liable to cause penetration of the spraying materials into a water source. Under the Streams and Springs Authorities Law, 1965, the minister is authorized to establish stream authorities and to determine their functions and responsibilities. Under the Local Authorities Law (Sewage), 1962, activities related to sewage (maintenance of the system or the selling of sewage water by the local authority) must be performed such that they satisfy the health authority, by a person appointed by the Minister of the Environment (Goldman, 1996).

Ministry of Health

The Ministry of Health is in charge of implementing the National Health Ordinance (1940). To implement this law, the minister is authorized to promulgate regulations that define the sanitary quality of potable water, determine the sanitary conditions of water sources designated as potable water sources, and regulate the sanitary aspects of planning, installation and operation of potable water systems. To handle the sanitary quality of water, the Minister of Health appoints one of his employees as a "health authority" (as in the case of the Ministry of the Environment). The ministry may instruct the holder of a water source to take the measures required to prevent a health hazard or to improve the quality of the water.

The Ministry has created sewage and effluent water regulations that require large sewage producers (public authorities or factories) to treat sewage in a purification facility, so that it reaches the quality level prescribed by the regulations. The Minister of Health may, in conjunction with the Minister of Agriculture, determine rules for the purification of sewage water designated for irrigation or other economic purposes. These rules prohibit the use of drainage water without a permit from the minister. This permit will not be granted unless it has been proven that the water has been sufficiently purified. The Ministry has promulgated regulations prohibiting irrigation of agricultural crops by water that has not been treated in a purification system approved by the Ministry of Health's district sanitation engineer. Effluent water is permitted for use only for those agricultural crops not designated for human consumption (such as cotton) or for crops which undergo industrial processes which prevent transmission of microorganisms (such as grains and sugar beet). Pursuant to the Local Authorities Law (Sewage), 1962, a plan for the establishment of a sewage system requires the approval of the Minister of Health (Goldman, 1996).

Ministry of the Interior

The Ministry of the Interior is in charge of the local authorities. By controlling their

budgets, the ministry supervises the local authorities' water and sewage activities. Under the Local Authorities Law (Sewage), 1962, the ministry can obligate local authorities to install a sewerage system. Under the Water Law, 1959, the Minister of Agriculture must consult with the Minister of the Interior and obtain his approval for determining rates for water supplied to the local authorities and for water produced by the local authority, for any agreement to relocate a water factory to which a local authority is party and to appoint a local authority or association of municipalities as a regional water authority. Under the Drainage and Flood Prevention Law, 1957, the Minister of the Interior must be consulted before the Minister of Health can determine the extent of the local authorities' representation in a drainage authority, and all matters pertaining to drainage taxes.

The Minister of the Interior is in charge of implementing the Regulation of Public Bathing Places Law (1964), under which he determines the areas at the beach, rivers and lakes where swimming is permitted. He is also responsible for rulings, which determine the methods of maintaining sanitation conditions in authorized bathing areas.

Ministry of Foreign Affairs and Ministry of Defense

The Ministry of Foreign Affairs is involved in the political and security aspects of Israel's water policy vis-à-vis neighboring and remote countries. The Ministry of Defense, as a consumer and as a party to the protection of the country's water facilities and the water that reaches Israel from neighboring countries, has a vested interest in water-related activities occurring outside its borders.

Water Supply Companies: The Mekorot Water Supply Co.

Mekorot is Israel's national water company. Founded in 1937, its objective was to develop the country's water supply systems. Mekorot controls the water system nationwide according to the Water Law (1959). As a state-owned company, Mekorot operates independently under the supervision of the Government Companies Authority but is affiliated to the Ministry of Infrastructure and the Ministry of Finance, and supplies water in bulk to municipalities, farmers, and industry.

The company currently provides 65% of the water consumed in Israel and serves 4,800 customers, which include municipalities, local councils, moshavim, kibbutzim and regional associations. In 1998, the company supplied 1501.9 million cubic meters of water. Of that amount, 794.0 went to the agriculture sector, 89.8 to industry, 618.1 to domestic consumption and the remaining 27.9 cubic meters was introduced into the biological system.

In financial terms, Mekorot accounts for 80% of the water industry's activity in Israel. Costs are relatively high since it transmits water over long distances and pumps water to high places. Most other associations and private manufacturers supply local water demand at lower costs. In the past, all of Mekorot's expenses were passed on to its consumers and the government. Since 1993, water prices are no longer controlled by Mekorot but are determined by the government. This cost arrangement has changed the nature of the company's activities and forced it to become more business-oriented. The arrangement has

resulted in an improvement in the efficiency of its energy use, a significant increase in investments in water facilities, and renovation of existing equipment. The company has also been forced to attempt to enter new fields in order to expand and diversify its business.

Box 3: Partnership with Mekorot: The Hefer Valley Water Users Association

The Afikey Emek Hefer Association is a voluntary agricultural cooperative, which brings together member farms in the Hefer Valley. Established in 1984 it consists of 26 member settlements of kibbutz's and Moshavs. The Association is an independent unit and represents the Hefer Valley Regional Council in water and sewage issues, and is in charge of maintaining water sources in the valley. The Association undertakes operations to ensure water supply sources for all valley users in terms of research, physical maintenance, economics and legal issues. To achieve this, its water supply system is jointly owned and managed with Mekorot whose role is to operate and maintain the system. Expenditures and investments are jointly shared between the Association and Mekorot. Senior management of the company participate in regular policy meetings with the Association, and at the operational level there is continuous interaction between the Association and staff of the Mekorot's Central District Division. A characteristic of this arrangement is the involvement of he farmers themselves as well as advisory services from relevant government agencies in water management issues in the Valley.

The partnership between Mekorot and the Association is widely regarded as being highly successful, as illustrated by the increased efficiency of water use that has been realized in recent years. Financial and technical support provided by Mekorot for sewage treatment, water reclamation, and more efficient irrigation technologies have been a model that the Association is keen to demonstrate to others.

Source: Shaul Manor and Zeev Hagali, Survey on Irrigation Modernization, FAO, December 2002

However, Mekorot is still the only entity with significant financial and operational capability in the field of water resources, and it remains a monopoly with too much power. The water associations and private producers are small businesses with limited financial capability. Mekorot remains the leader in the water sector, and it operates without proper supervision. Its size intensifies the centralization of water resource management which continues to augment its financial strength.

Although there are many good examples of how Mekorot has worked in partnership with others to improve water management efficiency (see Box 3), it is feared that the water system is developing according to Mekorot's needs, which is not necessarily compatible with the goal of the country in terms of allocating water resources efficiently and fairly. Mekorot's continuing expansion in new directions in water resources, such as desalination, will increase the monopoly's strength and intensify its power. This is liable to draw the national economy into excessive expenses and greatly increase the price of water to the consumer. In 1997, the Arlozorov Committee for Examination of Water Resources Management suggested encouraging other private entities and local authorities to enter the field of desalination.

Other Water-Related Entities

Water Associations and Private Producers

Water supplied by private parties, primarily for agricultural use in the northern part of the country, is managed by regional water associations. In most cases the associations belong to consumers who are farmers in the regions. These associations may either act

independently or jointly with Mekorot in supplying and allocating water resources. Their financial ability is limited and they need assistance to establish their water supply facilities. In particular, they do not have access to the guarantee or credit terms that Mekorot was granted in the past (Arlozorov, 1997).

Local Authorities
These are responsible for the water and sewage services within their jurisdiction under the Municipalities Ordinance, ensuring that residents in their jurisdiction pay the water fee.

The Water Council
The Water Council is a national entity appointed by the government to advise the Minister of Infrastructure on a wide range of matters pertaining to water policy. The minister must consult with the council before promulgating secondary legislation, and specifically with regard to tariffs. The Council has about 30 members, including representatives from the Ministry of Agriculture, the Water Commissioner and other government representatives, consumers, suppliers, and producers, as well as a representative of the World Zionist Federation. The Council appoints one committee to discuss matters related to agricultural water use and another one for other water uses.

The Planning Committee
This is appointed by the Minister of Agriculture and has 11 members. Its job is to examine plans for water facilities.

The Consumer Representative
At the local level, this includes representatives from local authorities, suppliers and agricultural and industrial organizations (Goldman, 1996).

The National Drainage Council
This Council provides advice on matters pertaining to the implementation of the Drainage Law. The council members include the Water Commissioner, 8 government representatives and 12 members appointed by the minister, 8 of whom represent agricultural organizations. Each drainage area has a drainage authority in which the majority of members are representatives from the local authorities in that drainage area, the remainder being government officials who operate with the approval of the Minister of Agriculture (Goldman, 1996).

Lakes and Streams Authorities
These are composed of the following groups of members. The first group consists of government officials who are representatives of the local authorities within the area of the Lakes and Streams Authority; the second group includes representatives from the corporations that use the water from the streams (the Nature Preservation Authority), and the third group the representatives of property owners whose land borders on the stream. The authorities have various responsibilities. First, they regulate water utilization in the stream, maintain an environmentally healthy water level and ensure regular drainage. Second, they determine the course of the stream, remove hazards that may pollute the stream, and preserve the natural landscape of the stream and its banks. Third, they regulate water distribution among interested parties, regulate the ways to utilize the stream, and rehabilitate the stream for recreation and vacation purposes.

There are currently two Lakes and Streams Authorities – The Yarkon River Authority established in 1988 and the Kishon River authority established in 1994 (Goldman, 1996).

Sea of Galilee Administration

This fulfills an important function in terms of protecting the water quality in the lake and preventing water pollution in the drainage area. However, its status is not defined by law. In fact, it is a type of coordination committee that connects various official entities, such as the Water Commission, the drainage authorities, the Ministry of the Interior, and the Israel Lands Administration.

Farmers

Farmers controlled water resources during the country's early years. The Minister of Agriculture was, traditionally, a kibbutz member or a member of the moshav movement. The Water Commissioner originated from the agricultural settlement, and there were many kibbutz and moshav members on the Knesset Water Committee. In practice, the situation is not very different now, with farmers continuing to play a dominant role in the allocation of water resources. However, as a consequence of arid years and over-use of reservoirs, concern about current and anticipated water shortage has become a major national issue and there has been strong pressure to change the principles of water resources management.

CHAPTER 5
STRATEGIES FOR WATER RESOURCE MANAGEMENT: TECHNICAL APPROACHES

Water resource strategies continue to evolve in Israel, with various technical options being developed or considered. These include utilization of recovered water, desalination, importation of water, construction of a national carrier, agricultural and industrial efficiency improvements, and urban water use standards.

Extensive Utilization of recovered water

Regulations have been initiated in order to improve the quality of sewage treatment plants and their effluents to maximize water reuse potential, and to minimize health and environmental risk. A particularly important objective is to replace fresh water supplies currently used for irrigation purposes by treated wastewater effluents. By 2003, Israel was re-using 65% of its waste water, and almost 50% of the total irrigation sector is now using treated sewage effluents (Saul, 2005).

Desalination

To augment its existing relatively small scale desalination plants, and as a result of the recent dry spells and growing water demand, the government has decided to initiate and accelerate the construction of Reverse Osmosis Sea Water Desalination Plants (ROSWDP), which will add about 10% to the total fresh water availability of the country in 2005/6. This follows a period of intensive research and significant cost reductions of ROSWDP based mainly on local changes in the design of these plants. This decision also includes the completion of nationwide treatment and re-use of all of its treated waste water (tertiary and secondary treatment) and allocating these new sources of water to the farmers in exchange for their fresh water allocations.

Importing water

Turkey is considered Israel's best source of imported water from the mouth of the Manavgat River in southern Turkey to the Ashkelon Port, 600 km away. Water may be transferred using a submerged pipeline, super tankers or floating bags. The Manavgat River has an average flow of 140 cum/sec, of which 60 cum/sec are assumed to be available for export (15% of the unused water on the Turkish Mediterranean Coast). The use of super tankers, with a capacity of 250,000 tons, is currently being considered. They would unload near Ashkelon Port, on an existing floating Single Buoy Mooring (SBM) stationed 3.25 km from the coast. The existing facilities, including the SBM, the floating hose and the submerged pipes connecting the SBM to the coast, would have to be cleaned for water use.

The cost per cubic meter is estimated at about $0.80 to $1.00 for supertanker shipment, versus between $0.60 and $1.25 for seawater desalination. However, unloading and conveyance facilities

(seasonal storage, pumping station, inland transmission conduit, SBM, marine unloading pumping station and the submerged pipe) would add a further 50% to this cost. The excessive cost, reliability and the doubt about uninterrupted supply and long-term availability, render importation a less desirable option for solving Israel's water deficit.

National Carrier

As part of the nationwide network for the available surface and ground water resources, a national carrier was completed to transfer the water surpluses from the relatively water abundant north to the water scarce center and south. This investment enables the authorities to maintain a balanced national pumping pattern, monitoring hydro-geological conditions at all times and throughout the country. Desalination of brackish and sea water have become the main means of adding water quantities when natural supplies and re use fail to meet the growing demand for water.

Demand Management: Technical Aspects

Agricultural and Industrial Production Sector
Irrigation water allocations are based on norms developed by the agricultural research community together with the farmers. The norms aim to maximize economic gains by introducing new irrigation technologies, changing cropping patterns, and moving away from crops – such as grains - where the product value per unit of water is relatively low.

A similar policy was adopted by the industrial sector in order to reduce per unit water usage as well as pollution. After a survey is conducted, an implementation policy is formed which requires the establishment of a special fund, a nationwide program for each industry, and an allocation system that aims to improve the productivity per unit of water that is used.

Box 4 Irrigation Water Management

Israel is a world leader in the area of irrigation water management in arid environments. Based upon the greater agricultural efficiency of drip irrigation and micro-sprinkling compared with furrow irrigation in Israel (90% compared with 64%), the country has over time carried a major technological switch in irrigation practices. The improved technologies, combined with changes in cropping patterns and moving to higher value crops, have had dramatic results. Thus the average requirement for water per unit of land has been reduced from 8,700 cubic meters per hectare in 1975 to 5,500 cubic meters per hectare today. With water consumption remaining the same, agricultural output has increased twelve fold.

Source:
www.jewishvirtuallibrary.org/source/History/scarcity.html

The Urban Sector
The urban sector has adopted several measures to improve water use efficiency. Those measures include: water metering, pipe replacement, and electronic monitoring and retrofitting campaigns. Double-volume toilet flushing basins, and recently redesigned standards for taps and showers, were the legally enforceable basis for a 25-year program. The effectiveness of this can be seen from the fact that per capita urban water consumption in Israel has hardly changed in the past 40 years despite an increase of 300% in GDP during that period.

CHAPTER 6
WATER RIGHTS, ECONOMIC INSTRUMENTS AND FINANCING

Water Rights and Allocation

Water Rights

Soon after the establishment of the State of Israel in 1948, the issue of water became a top priority. Urgency was seen not only in planning and carrying out projects and securing funds, but also in consolidating a legal framework that would regulate all the elements pertinent to the matter of water supply.

Accordingly, in 1959 the comprehensive Water Law was passed in the Knesset (the Israeli Parliament). The Water Law states that all sources of water in the state are public property, subject to the control of the state and dedicated to the needs of its inhabitants and the development of the country. Water sources are defined to include all internal sources of water, including springs, streams, rivers, lakes and other current accumulations of water, above the ground or underground, including drainage water and sewage. Each person is entitled to obtain water and to use it, subject to the provisions of the Law.

The priority for water allocation is first for domestic use and then to commerce, industry and agriculture. Supervision of all matters related to water is managed by the Water Commissioner who is responsible for carrying out a comprehensive and balanced policy of water production and supply at the national level. The Water Law prohibits the drilling of wells without a license from the Water Commissioner. It has the power to set quantity and quality standards for those who have the right to receive water. Farmers are forbidden to use water in excess of the amount allocated to them by the Water Commissioner, even if they have their own well. Water meters at the well are read and controlled by staff of the water Commissioner's office. Water pollution is forbidden and punishable by fine or imprisonment.

The Law stipulates the basic rules for state control of water charges, and provides for the establishment of a Water Charges Adjustment Fund to reduce differences in water charges in various parts of the country. The Water Metering Law forbids the supply and abstraction of water without measurement.

Water Allocations and Permits

It was recognized early on that water, as a resource in a short supply, required a legal framework and the prescribing of engineering, economic and administrative actions in order to attain its efficient utilization, in accordance with the goals set by the State.

Most regions in the country were declared as "rationing regions", which means that water consumption was limited to a fixed amount. Therefore, norms were established for agricultural consumption, domestic consumption and industrial consumption.

Since the promulgation of the Water Law, an annual water production and supply license is issued to every producer and supplier. The production license is a fundamental document reflecting the Water Commissioner's provisions regarding the amounts of water allowed for production, supply or consumption, conditions of production, and the restrictions to which it is subject. The first priority is given however to municipal and domestic supply.

Water allocation for private agriculture began with the enactment of the Water Law. The initial stage was the recognition of water usage rights (not water rights). The allocation of water rights was done by photographing the farmers' areas, and measuring the quantity of water consumed in certain period. After that, usage norms were established for different crops, and water use quotas were calculated by multiplying the norms by the areas of crop cultivated.

Water allocation for planned settlements was determined by the types of soil and means of water production as well as the maximum size of the settlement measured in terms of the number of units. The maximum water allocation for each settlement was obtained by multiplying the number of planned farm units by the water quota per unit.

Since 1986 the Water Commission has been following a policy of water quota cutbacks. A cutback was made in most parts of the country, due to the reduction in pumping from the coastal aquifer (Pleistocene aquifer), which was undergoing a rehabilitation process. An important change initiated in 1993 was the flexibility in the annual allocation date. In January, 70% of the overall allocation is determined for each agriculture sector consumer, with the remainder of the allocation determined during the winter according to the hydrological situation, but no later than April 1st of the same year. In 1999, after severe depletion of the country's water resources, the Water Commissioner decided on a reduction in the water quotas for agriculture (1998 was set as the basic year for the cut) by a 40% average and in the years 2000 - 2002 an average reduction of 50% was decided on.

Establishing quotas for industrial plants that use more than 5,000 cubic meters of water a year is done based on the quantities ("norms") of water consumption, according to the type of product and scope of production. The multiplication of the aforesaid norms by production scope constitutes the basis for water allocations in the plant. A plant whose wastewater disposal system does not meet the required criteria does not receive a water consumption license.

The amount of water allocated to domestic consumption includes water for household needs, gardening, auxiliary farms, services and public utilities, trades, commerce, etc. within the domain of the local authority, or in other words, the overall shared consumption of the local authority, excluding separate allocations for industrial and agricultural needs within its domain.

In recent years the amount of water allocated to local authorities has not been fixed. Every local authority is entitled to use the amount it requires for various purposes. However, the amount of water the local

authorities sell to consumers within its boundaries should not be more than 12% of the total available water in the regions. If the consumption difference is higher, the local authority is given a monetary fine ("special payment").

Fees and Prices

Mekorot provides two thirds of the water supply in Israel. The prices the company is entitled to charge are set by the Ministries of Infrastructure and Finance, as approved by the Knesset's Finance Committee (The Israel Water Commission, 2002). Prices are updated from time to time according to changes in the consumer price index, electricity rates and the average wage index. The rates are categorized according to use: - primarily, domestic, industry and agriculture. While some subsidization is employed, prices are essentially based on the costs of supply.

Water Costs

The unit cost of water in Israel has increased sharply over the last 45 years, as might be expected in a water-short country. In 1960, water was primarily supplied by local sources, at relatively low cost. The advent of the national carrier in the mid-1960's involved heavy investment in water pumping, large conveyance systems and treatment plants, which increased unit costs considerably in the early years of that project. Nevertheless despite having to access ever more expensive sources, unit costs between 1970 and 2001 did not increase greatly. This can be explained in part by greater utilization of the new capacity and improved operational efficiency on the part of the main supplier, Mekorot.

Unit costs of raw water supply (at the city gate) in $US equivalent (constant 2002 prices) were as follows:

Year	Cost per Cubic Meter
1960	0.12
1970	0.35
2001	0.45

Source: Yoav Kislev, The Water Economy of Israel, 2006

The cost-plus method previously used by Mekorot to calculate water prices was replaced in 1994 with a business oriented method in which the government now determines recoverable fixed and variable costs. A substantial increase in water prices was approved by the government, and this, coupled with improved performance (saving in energy cost and other variable and fixed costs) resulted in a significant reduction in the government's subsidy from 40% to 20% over the following four years. It has remained at roughly this level of support ever since. However, water supplied to the urban and the industrial sectors incurs the full cost, while water supplied to agriculture continues to be subsidized. (see Section 6.4 below for more details).

Agricultural Use: Reclaimed Water.

With regard to reclaimed water, the government supports the agricultural sector by providing subsidies for initial capital investments approved by the Investment Committee, which is composed of representatives from the Ministries of Agriculture, Treasury, Health, Environment, and the water authorities. The committee evaluates proposed projects based on

technical, economic and managerial criteria. The cost difference between the production price and the price at which the reclaimed water is sold is covered by a government subsidy.

The cost of supplying one cubic meter of reclaimed water from the outlet of the treatment plant to the farmer's field is currently estimated at about $US 0.21[1]. This includes: 70% capital recovery cost and 30% operational costs. Operational cost includes: 35% for maintenance of lines, reservoirs and pump stations, 40% for energy, and 25% for other operating costs and management.

Farmers are charged between $0.13 and $0.19 per cubic meter for reclaimed water, depending on quality. The balance is covered by the government as a subsidy. The payment is based on the actual number of cubic meters of reclaimed water used by the farmers.

Agricultural Use: Fresh Water

With regard to fresh agricultural water, the tariff schedule is designed to discourage farmers from using their complete entitlement. For example, the amount they pay to the main supplier, Mekorot, increases according to the amount purchased, current rates being as follows:

- $0.28 per cubic meter up to 50% of their entitlement
- $0.33 per cubic meter for the next 30%,
- and $0.43 per cubic meter for the rest

Source: Yoav Kislev, personal communication, 2006.

Extraction Levies

As from 1999 all those extracting water from any source have been charged with an extraction levy payment. Current rates for agriculture are 0.19 per cubic meter from underground sources and $0.06 from surface water. (Households and manufacturing pay between $0.18 and $0.22 per cubic meter depending on the source). The actual rates are updated from time to time. The obligation for payment of the extraction levy falls on the actual extractor, who is entitled to collect from his consumers their share of the extraction levy as well as other water supply costs, in accordance with the quantity of water supplied to them. If the water extractor does not pay the extraction levy, the Water Commissioner has the right to cancel, to suspend or to change the extraction license of that extractor for that water source.

The extraction levy is not based upon the immediate cost of supply, but rather reflects the scarcity value of water. This is a unique and extremely important aspect of Israel's water policy (Kislev, 2006).

At the same time, in order to improve water use efficiency, the law provides a system of grants to be made to private extractors from the State budget, for the production and development of inferior quality water sources to be converted into higher quality supplies. This is designed to permit the continued existence of private water extractors, who are a positive competitive factor in the water economy, particularly where their operations return hitherto low quality water to drinking water standards.

Municipal and Industrial Consumption

Water tariffs and allocations are applied to groups of consumers, namely, towns, local councils, and water user associations. Water

[1] Using 4.4 NIS/$US exchange rate

prices are fixed by a parliamentary committee based on recommendations made by the Ministry of Finance and the Water Commission. Increasing block rates are used to discourage excessive consumption while allowing basic needs to be met. Currently, prices (including a sewage charge) for most households, as passed on by the municipal authority concerned, are as follows:

- First 8 cubic meters per month: $0.80 per cubic meter
- Next 7 cubic meters per month: $0.95 per cubic meter
- Additional Amounts: $1.51 per cubic meters
- Minimum charge per month: $3.50

In addition, the average charge for manufacturing uses is $0.56 per cubic meter.

Financial Support

The government, through the relevant ministries, provides grants and low-interest loans for improving and expanding water supply and wastewater treatment plants. Investment capital is distributed through the Water Networks Rehabilitation Fund, the National Sewage Program, the Irrigation Systems Improvement Fund, and the Wastewater Renovation and Reuse Program.

Most significant of all however is the subsidization of irrigation water by the Ministry of Agriculture, which encourages wasteful use. Furthermore, many farmers also receive subsidies to cover this under-priced water and receive cash compensation when their water allotment is reduced. For fresh water farmers pay on average $0.25 per cubic meter to Mekorot. This is $0.20 less than the price paid by urban users. Since the latter cover full costs of supply, the figure of $0.20 per cubic meter can therefore be seen as a rough indication of the amount of subsidy.

Water subsidy has been one of the most expensive items in Israel's state budget. With the expectation of cutting subsidies for public transportation, water subsidies will be the main budgetary subsidy in Israel. For example, in 2000 NIS 298 million (approximately $73 million) was allocated for direct water subsidization, which is about 27 percent of the entire water system governmental budget.

Another form of subsidy involves seasonal water use. It is more expensive to pump water in summer months, yet there is no surcharge for this water to force users to compensate for the cost (There was a surcharge added to summer consumption during 1978-1988, but it was dropped, apparently due to political pressure from farmers).

Under-pricing of pumping and distribution services provided by Mekorot is another type of subsidy. As noted above, government financial support to the company, albeit declining, remains significant.

Until recently a major source of distortion in the water market was the water equalization fund. The idea was to penalize those who had access to cheap water sources (such as farmers with their own wells) and use the proceeds to compensate those who use more expensive water sources. The rationale of such fund was fairness. The result, however, was to further distort water allocation. The equalization

fund payments eliminated the incentive to seek and exploit cheaper water sources. It subsidized the uses of the most expensive sources of water. The operation of the equalization fund lasted for decades, but was finally eliminated in Israel in 1999 as part of the Arrangements Law (Hok Hahesderim), and was replaced by a set of differential tariffs for drawing water from the various sources of water.

Similarly, there has been a tendency in Israel to absorb transport differences for water consumption in different parts of the country, especially for water pumped from the Sea of Galilee and transported through the national water carrier (Hamovil Ha'artzi). The idea is that it is considered unfair to ask farmers far from the water sources to pay their own water transport costs. This creates a further distortion, leading to overuse of water at the destinations far from the sources. The traditional justification has been on grounds of subsidizing population dispersal to distant areas. Leaving aside a discussion of whether the government should be involved in population dispersal at all, water subsidization is an inferior method for achieving this result. Simply subsidizing directly the relocation of people and capital to peripheral areas of the country would accomplish the same goal without encouraging over-consumption of water.

Finally, it is important to make a distinction between subsidization in purely financial terms and in real economic terms. It appears that in Israel, since use of natural sources and water-reuse as well as demand-side options appear to be approaching their limit, there is little alternative to desalination as the future source of incremental supply. In other words, the unit cost of desalination is the appropriate measure of the true economic (marginal) cost of water in the country. Give current technology, the cost per cubic meter of this option is somewhere between 0.60 and 1.25, including incorporation of desalination water into the national grid. Assuming the lower of these cost estimates[2], with current price paid to Mekorot by farmers being $0.25 per cubic meter the subsidy amounts to about $0.35 per cubic meter for irrigation water use. Using a similar calculation, even urban uses are subsidized: the price municipalities pay to Mekorot is $0.45 per cubic meter, the subsidy therefore being $0.15 per cubic meter if the low-cost estimate for desalination is used as the benchmark for determining subsidy.

Water Trading[3]

The government has recently approved a change in the water code enabling holders of water allocations to sell their permanent or temporary allocations to others by transferring the actual transaction via the national water carrier, thus opening the sector for a market-like operation. This is similar to the policy that the Water Commissioner's office has been implementing for years in trading fresh water with treated sewage effluents. This market concept could well serve and even promote peaceful exchanges of water between the countries of the Middle East.

Water in Israel is used within a system of allocations (annual or multi-annual) while in most other countries in the region it is user rights that determine the demand. In

[2] As suggested by Kislev (2006)
[3] Source of much of this material is Arlosoroff (2005)

many regions, a person who owns land (or cultivates it) has the right to the water flowing beside or under the plot. In other regions various quota systems allocate the amounts of water on an annual, monthly, weekly, daily, or even hourly basis. Old established users usually have the rights to continue to use the resource, when shortages prevail.

In Israel it has been shown that the efficiency of water resource allocation and use can be substantially improved through the increased use of price and trading mechanisms. Trading water on the margin or using a system in which urban/industrial demand is met by supply from farmers selling their quotas reduces the inefficiency of administrative allocations. Replacement of the traditional administrative allocation system by the introduction of water trading using the national water system should greatly improve the efficiency of water use in the country.

Private Sector Participation

The general view is that market forces are the most suitable tools for the efficient use of water in the urban and agricultural sectors. Accordingly, water prices that are determined by the Government, based on the existing non-tradable allocation system, should be converted into a market negotiating system. This change would eventually lead to a greater involvement of the private sector in the production and supply of water to the various consumers. Further, it is anticipated that rational water use will be achieved by the creation of new water suppliers, carved out of Mekorot. The role of Mekorot should be limited to the operation of the national carrier, while the regional water supply schemes should be privatized and defined as public services under the supervision of the Water Commissioner.

In particular, the urban water sector is expected to undergo a profound reform, stemming from the introduction of the new corporation law, under which the municipalities are to transfer the management of the municipal water supply to private sources. The aim is to ensure that activities in the municipal water sector will be carried out through independent, profit-making enterprises.

The Israeli government currently lists increasing competition as one of the goals of national water policy. The budget proposal for fiscal 2000 states as a goal: "Increasing business competition in the areas of the water system, especially in the reuse of waste water, granting the economic right to produce water, quality control and distribution of water, with the intention of reducing the costs of water supply." Decision 136 of the government (1999) called for introducing elements of competition in water production, especially in water drilling. All drilling is supposed to be conducted henceforth through competitive tendering. Despite a broad law that already requires the awarding of government contracts through competitive tendering, this had not previously been standard practice in the water sector.

Privatizing the main sources of water in Israel is not a realistic idea, for the simple reason that it is not feasible to establish

property rights in a competitive setting for the water in the Sea of Galilee and the underground aquifers. If two or more corporations would have access to any of these sources, each would have motivation to over-pump and under-conserve. The over-consumption urge would be transferred to them, replacing farmers as the main driving force. This is a problem that has become familiar in other settings, such as utilization of underground oil fields by two or more companies. Essentially the problem is that such arrangements grant pumping or utilization powers to private corporations without assigning property rights in the resource itself, which is in effect shared.

CHAPTER 7
CONCLUDING REMARKS

To date the Israeli government has been highly successful in addressing the water problems it has faced, while maintaining a steady rate of economic growth and accommodating the demands of an increasing population. Key aspects have included its system of allocating water resources to designated sectors, and within that allocation rigorously enforcing compliance and economic incentives to achieve efficient resource use.

Its achievements in the agricultural sector have been particularly outstanding. It is clear that economic incentives have played a key role in stimulating innovative technologies, most obviously in irrigation, but also in manufacturing and urban water use. The extraction levy system, where charges are designed to reflect the scarcity value of water is of key importance, as is the increasing block system used for agricultural and domestic uses, with all uses (including individual abstractions) being metered and sewage costs incorporated into municipal water rates.

Nevertheless severe problems remain: existing sources of supply can no longer meet growing needs. Rapidly increasing marginal costs of supply, exemplified by the costs of desalination, require still further improvements in pricing policy. Subsidization of irrigation water – considerable in purely financial terms and even greater in economic terms - requires re-evaluation. Moreover, even urban and other uses of water should increasingly be priced at rates reflecting real (incremental) costs of supply. This also implies the need to ensure that regional and geographic variations in water supply costs are reflected in differential water prices; achievement of social equity should not be handled by means of water pricing.

Inefficiencies in the urban sector continue to prevail. Inadequate operation and maintenance leading to leakage and waste of water is an on-going concern. To help address this problem, although not a panacea, privatization of urban water supply systems is advocated, as well as promotion of competition with regard to bulk supplies. While public ownership of basic common water resources is required, efforts should be made to introduce a system in which allocated rights can be traded.

REFERENCES

Arlozorov, S., (1997) *Report of the Committee for Examining the Management of Water Supply in Israel* (Jerusalem: Ministry of Infrastructures, 1997).

Goldman, M D., (1996) *Managing the Water Systems – the Legal Framework in Israel* Jerusalem: The Florsheimer Institute for Policy Studies.

Issar S. Arie (2000) *The Water Resources of Israel Past, Present, and Future----- A comprehensive outline*, April 2000.

Kislev, Yoav, (2003) *Urban water in Israel*, in Agethe, Donald E., Bruce Billings, and Nathan Buras (eds), Managing Urban Water Supply, Kluwer, 2003.

Kislev, Yoav, (2006) *The Water Economy of Israel,* in Rageb, Jamil, David Hamberg, and Joseph Ginat (eds) Water in the Middle East, Oklahoma, 2006

Laster, Richard (1976) *The Legal Framework for the Prevention and Control of Water Pollution in Israel*, Ministry of Interior, Jerusalem.

Lester, Richard (1980) *For elaboration of the legal aspects of water*, see, "Legal Aspects of Water Quality Management in Israel," in Hillel Shuval, ed., Water Quality Management under Conditions of Scarcity: Israel as a Case Study (New York: Academic Press, 1980).

Manor, Shaul and Zeev Hagali (2002). *Case Study from Israel Survey on Irrigation Modernization,* The Hefer Valley Water Users Association, http://www.fao.org/AG/agl/aglw/watermanagement/docs/MOD_Israel.stm#1

Saul, Arlosoroff (2005) *Water Demand Management – A Strategy to Deal with Water Scarcity. Israel: A Case Study* www.ipcri.org/watconf/papers/saul.pdf

Soffer, Arnon (2002). *Mapping Special Interest Groups in Israel's Water Policy.* http://www.biu.ac.il/Besa/waterarticle7.html

State Comptroller (1990), *Report on the Administration of Israel's Water Economy.* Jerusalem: State Comptroller (1990):p. 53. [Hebrew]

Tal, Alon (1994) "*Law of the Environment,*" *Israel Business Law,* Kaplan, Ed. Boston, Kluwer, p. 241-353. (Reprinted, 1995)

Tal, Alon, (2002) *Pollution in a Promised Land, an Environmental History of Israel*, University of California Press, Berkeley.

The Israel water commission. *Israel's Water Economy - Thinking of future generations*, 10 Aug 2002

Zaslavsky, D.,(2001) *The Face of Water in Israel* (Haifa: Technion).

Useful website links

Waternet On the geopolitics of water scarcity in the Middle East

http://www.waternet.be/jordan_river/policies_israel.htm

State of Israel Ministry of the Environment

http://www.sviva.gov.il/Enviroment/Static/Binaries/index_pirsumim/p0394_1.pdf

Ministry of National Infrastructures

http://eng.mni.gov.il/english/units/Water/WaterResourcesandWaterAvailability.shtml

http://www.jewishvirtuallibrary.org/source/History/scarcity.html