

## PART II

### Chapter 4

## Water

*Water scarcity is a major concern in Israel, a country subject to arid and semi-arid climatic conditions. Water consumption exceeds the natural rate of replenishment and pollution loads intensify pressure on water resources. To respond to these challenges, Israel has implemented an advanced water pricing policy and has encouraged innovation in water-related technologies. As the water crisis has deepened, following several consecutive years of drought, more emphasis has been placed on increasing supply through an extensive programme of seawater desalination. This chapter assesses the effectiveness and efficiency of such components of Israel's water policy, as well as of water quality management.*

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## Assessment and recommendations

Israel's limited water resources are under severe pressure due to the country's geo-climatic location, rapidly expanding population, growing economy, and water pollution loads. Responding to these threats and opportunities, Israel has introduced some ambitious water policies and has been at the forefront of developing efficient water technologies.

Pressures on water resources have intensified in recent years, as Israel has faced the worst water crisis in its history. From 2003/04 to 2010/11, the country experienced almost seven consecutive years of drought. Water consumption exceeds the natural rate of replenishment, while the intensity of freshwater use is extremely high by OECD standards. Groundwater is being used unsustainably and a potentially serious pollution problem (including salinity and nitrates) is developing, particularly in the Coastal Aquifer. Climate change is further intensifying pressures on water resources.

Israel has pioneered water-efficient technologies such as drip irrigation, soil aquifer treatment for reuse of treated wastewater, brackish and seawater desalination, and large-scale filtration of lake water. Recently, there has been increasing reliance on economic incentives and other instruments to reduce demand for scarce water resources. Practically all water consumption is metered. Use of "smart metering" is growing. Water prices have significantly increased, and rising block tariffs provide incentives to conserve water resources. However, further steps could be taken to reduce household consumption in line with good international practices. A 40% increase in domestic water prices, introduced in January 2010, was a bold step which will help to address this issue. A marine pollution tax for direct discharges of effluent to seawater is currently under discussion.

Overall, Israel has achieved full recovery of the costs of supplying water services and this is an established policy principle, including for the agricultural sector. However, about 35% of agricultural uses of potable and reused water are still cross-subsidised by the household sector and receive a relatively large share of public support. The 2006 Farmers' Agreement contains a commitment to achieve an agreed target price in the direction of full cost recovery by 2017.

As the water crisis has deepened, more emphasis has been placed on increasing supply. Israel has embarked on an ambitious policy of seawater desalination, with the aim of supplying 750 million cubic metres (about half the expected potable water needs of the urban, industrial, and agricultural sectors) by 2020. Its desalination plants are among the most energy- and cost-efficient in the world. However, a planned substantial increase in the production of desalinated water is based on a number of key assumptions. First, it is assumed that the agricultural sector can absorb steep increases in the cost of water as full cost recovery of supply is introduced. Second, no major change in the cost of producing desalinated water is foreseen in Israel's water supply outlook. This may be optimistic, as the price of desalinated water is linked to energy costs, which are important for both production and long-distance transport. Increasing energy prices could put the economic balance, and/or the political will to ensure full cost recovery, to the test. Although some

studies have been carried out, the environmental and health effects of seawater desalination (*e.g.* impacts on coastal biodiversity, health effects of desalinated water's low magnesium content) require further assessment.

Water governance has improved since 2007 with the creation of the Water Authority. It is responsible for the regulation of the entire supply-recovery cycle of water and oversees the national water grid, by means of which water may be transported almost anywhere in Israel (upstream and downstream). This situation is unique. In 2010, 60 million cubic metres of water (potable water and treated wastewater) were allocated for environmental purposes. Nonetheless, centralised management of water resources has not given sufficient weight to environmental considerations. River basin management authorities have been established, although their performance remains uneven. Environmental quality objectives have not been established for rivers. Major rivers, which once supported rich aquatic and wetland ecosystems, became seriously depleted and polluted. However, restoration and rehabilitation programmes have resulted in steady water quality improvements over the past five years. The reuse of treated domestic wastewater for irrigation means that most of this water is lost to evaporation and plant transpiration, leaving virtually none for river flows and aquifer recharge. However, addressing this issue would require greater use of potable water.

#### Recommendations

- Gradually increase the agricultural and industrial sectors' share in financing the full costs of water infrastructure, taking account of the positive externalities associated with water supply; establish targets for domestic water consumption in line with best practices in western European countries.
- Continue to carefully assess the economic assumptions and the environmental and health impacts of producing and using desalinated water; internalise environmental costs in the price of desalinated water.
- Consider broadening the use of economic instruments for water management, including: expanding the scope of the proposed marine pollution tax to effluent discharges in freshwater and aquifers; ensuring that extraction tax rates reflect water scarcity; introducing a pesticide tax with rates reflecting pesticide toxicity; and trading water quotas among different agricultural producers and, in the medium term, with other water users.
- Consider how local ecological conditions and minimum river flows could be better reflected in decisions on water allocation among sectors and to nature.
- Define water quality objectives for all stretches of rivers, and issue discharge and abstraction permits accordingly.

## 1. Institutional and legal framework

Israel is characterised by national level water governance. All decision making on water supply is carried out at the national level. Water corporations within the municipalities serve as “consumer liaisons” which transport water to their constituents.

Under the Ministry of National Infrastructures (MoNI) and pursuant to the Water Law (first enacted in 1959), the Water Authority has overall responsibility for the water sector. This includes: preserving the country's water resources; regulating the production, supply

and use of water; designing and implementing water supply schemes; and, through its Water Commission, allocating water and setting water prices in each sector (domestic, agricultural and industrial). Since 2007, primary responsibility for decision making rests with the eight elected members of the Water Authority Council, which represent the Water Authority, five ministries (MoNI, Environmental Protection, Health, Finance, and Foreign Affairs) and two representatives of the general public (appointed by the Minister of National Infrastructures).

The Water Authority also supervises the establishment of wastewater treatment facilities. The Local Authorities Sewage Law (1962) requires local authorities or the water corporations to maintain these systems. The effluent quality and wastewater treatment regulations, issued by the Ministry of Environmental Protection (MoEP) and the Ministry of Health in 2010, include 36 parameters that may not be exceeded in effluent whose use in irrigation will be unrestricted or that will be discharged to rivers.

Established in 1937, Mekorot, the National Water Company, supplies 70% of total water consumption. Water supplied to agriculture is mainly provided by Mekorot directly or by Agricultural Water Associations. Mekorot treats about 40% of the country's wastewater.

The Water and Sewage Association Law (2001) provides for the increased efficiency of municipal water supply and sanitation. Water and wastewater services are gradually being transferred to newly created public service entities called Water and Sewerage Corporations to ensure that there will be a "closed loop financial system" whereby all income from water tariffs will be reinvested in water infrastructure.

The Water Law declares that all water resources are public property subject to the control of the state. There are no private water rights or resources in Israel. Water may only be used by permit holders. This requirement extends to the water drawn from a well under a farmer's property, even if intended solely for the owner's own use (OECD, 2010a). The law was amended in 1971 to regulate activities which directly or indirectly cause, or may cause, immediate or subsequent water pollution. In 2004, nature was added as a legitimate use of water under the law. A special judicial court, the Water Tribunal, handles disputes pertaining to the Water Law.

The MoEP is responsible for protecting water quality and preventing water pollution. Some of these activities are funded by the Water Authority and carried out by the Kinneret Drainage and River Authority and the Lake Kinneret management organisation. Created in 2008, the Kinneret Association of Towns ensures co-ordination of land use planning along the lake's perimeter. The Ministry of Health sets and oversees standards for drinking water and, with the MoEP, sets the standards for effluent to be reused in irrigation or that flows back into the environment.

Pursuant to the Streams and Springs Authorities Law (1965), river authorities have been created to protect the Yarkon and Kishon Rivers and prevent further pollution. There are also 11 drainage authorities in Israel that protect river basins. Most of Israel's rivers are dry during most of the year. A small number of rivers such as the Yarkon (Tel Aviv), Kishon (Haifa), Sorek (Jerusalem) and Jordan flow year-round due to rain, springs, or the inclusion of effluent (from wastewater treatment plants) in the baseflow. National statutory planning guidelines control national and urban development in such a way as to protect public open spaces and nature (including rivers).

Under the supervision of the Ministry of Agriculture and Rural Development, and pursuant to the Drainage and Flood Prevention Law (1957), the 11 drainage authorities are

primarily responsible for drainage of agricultural runoff, including through channelisation of rivers. They are given environmental responsibilities by the MoEP, in accordance with the Streams and Springs Authorities Law, and must protect the environment in their daily activities. They are also responsible for flood prevention. The Lower Jordan River drainage authority has drafted terms of reference for a land use master plan for the Lower Jordan.

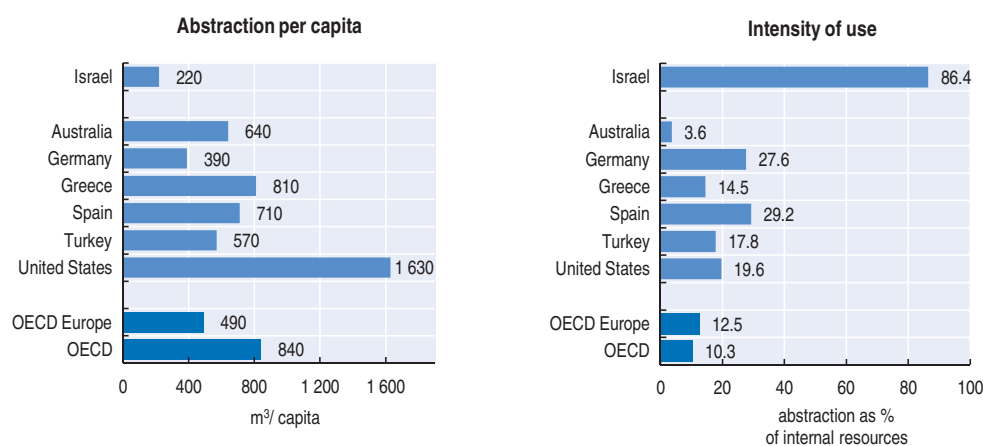
With regard to water monitoring, the Water Authority (mainly the Hydrological Service) monitors water levels and quality in Israel's major aquifers (including in the Lake Kinneret watershed). The Israel Oceanographic and Limnological Research station monitors the quantity and quality of water along the coastline of the Mediterranean Sea. The Nature and Parks Authority (NPA) monitors water quality in rivers on behalf of the MoEP. Mekorot and local authorities monitor drinking water quality under the supervision of the Ministry of Health. The Ministry of Health monitors effluent quality prior to its use in the agricultural sector.

## 2. Pressures on water quantity

Israel is characterised by arid and semi-arid climatic conditions, and water scarcity is a major concern. The main natural water sources are the Mountain and Coastal Aquifers<sup>1</sup> and Lake Kinneret, Israel's largest natural freshwater lake (and its surrounding watershed), which provides one-third of the country's water requirements and a higher proportion of its drinking water requirements. The agricultural sector is the largest water consumer (for all water types), followed by the domestic sector and, to a much lesser extent, the industrial sector. Israel's National Water Carrier, inaugurated in 1964, transfers water from Lake Kinneret and the aquifers to the highly populated centre of the country and the arid south. With the introduction of seawater desalination plants, flow directions will change. Water from Lake Kinneret will be consumed mainly in the north (in the vicinity of the Lake Kinneret watershed), while water from both the coastline and natural groundwater sources will flow country-wide.

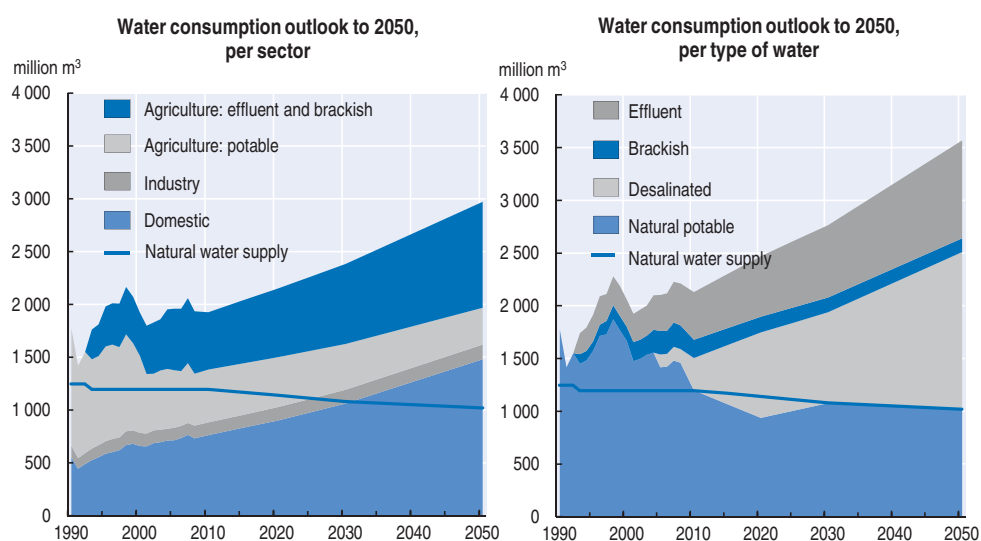
Intensity of freshwater use (abstraction as a per cent of internal natural potable water resources) is extremely high by OECD standards (Figure 4.1). Israel already consumes more water than its natural supply, which is essentially provided by rainfall. The annual deficit is currently 300 million m<sup>3</sup>/year. In addition, there is a need to restore depleted natural aquifers. The problem of water scarcity has been exacerbated in recent years by several multi-year drought cycles and the consequent over-pumping of water to meet growing water demand. Annual rainfall has decreased by 9% on average since 1993 and could decrease by a further 10-15% between 2015 and 2035, according to climate change models (Chapter 6). No upstream Jordan River water now reaches the Dead Sea, which has lost one-third of its surface area since 1930.<sup>2</sup>

The 2050 outlook for water does not give any reason for optimism. Increasing population and agricultural growth are placing additional pressures on Israel's limited water resources, in terms of both quantity and quality. As a result, despite significant progress in reducing agricultural use of potable water (by more than 50% within a decade), consumption of potable water will increasingly exceed renewable resources (Figure 4.2). The main government response has been to reduce demand by promoting drip irrigation and the reuse of treated domestic wastewater (effluent) in agriculture, and to increase potable water supply for the urban sector mainly through the construction of large-scale desalination facilities (Box 4.1). The goal is to increase effluent and desalinated water use

Figure 4.1. **Freshwater use, 2009<sup>a</sup>**

a) Or latest available year.

Source: OECD, Environment Directorate.

StatLink <http://dx.doi.org/10.1787/888932495209>Figure 4.2. **Water consumption outlook to 2050**

Source: Water Authority, Planning Department.

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in order to prevent increased demand on natural potable water resources up to 2050. Efforts are also being made to foster the role of economic instruments: significant increases in water tariffs have taken place or are planned in all sectors. Agricultural water quotas have been made more stringent. By law, all water supply must be metered.

### Box 4.1. Innovation in the water sector

#### Reuse of treated domestic wastewater (effluent)

The reuse of effluent in agriculture is high on Israel's water policy priority list. This reflects a combination of factors, including severe water shortage, contamination of water resources, densely populated urban areas and highly intensive irrigated agriculture. To ensure that high-quality effluent is applied to irrigated crops, soil aquifer treatment (SAT) has been used at the Dan wastewater treatment and reclamation plant in the Tel Aviv metropolitan area (130 million m<sup>3</sup>/year or about 25% of total wastewater treated). Effluent is discharged to sand infiltration fields, where it is treated by physical, biological and chemical processes before reaching the aquifer. The long retention time which is part of these processes produces a high-quality effluent suitable for all agricultural crops, with no restrictions and no risk to public health.

#### Large-scale desalination of seawater

The long-term construction programme for large-scale reverse osmosis seawater desalination began to contribute potable water to Israel's national water grid in 2005 when the Ashkelon plant, at the southern end of the country's Mediterranean coast, began operation. Three large-scale desalination facilities currently provide 320 million m<sup>3</sup> of potable water to all sectors, the equivalent of approximately 42% of current domestic water requirements. By 2015, 2025 and 2050, respectively, new desalination facilities along this coast are expected to cover 62.5%, 70% and 100% of domestic water demand. Any supplementary desalinated water available in these years will be used to narrow the gap between replenishment of Israel's natural water systems and increasing water demand.

In tenders for the construction of large-scale desalination plants, energy efficiency is maximised through a bidding system that promotes energy conservation in different ways, including giving preference to natural gas (rather than use of coal) and to efficient technological energy recovery systems. Israel's desalinated water production is therefore among the most energy-efficient (3.5 kWh/m<sup>3</sup>) and cost-efficient (USD 0.54/m<sup>3</sup>) in the world (Figure 4.3).

Most of the country's desalination plants have been, or will be, privately financed as build-operate-transfer (BOT) projects. In 2010, the cost of operating Israel's three large seawater desalination facilities was USD 260 million, including USD 20 million to transport desalinated water to users. The three facilities were built at a cost of USD 750 million. Construction of additional desalination facilities between 2010 and 2020 will cost approximately USD 1 billion, including USD 750 million to transport the water throughout Israel.

While large-scale desalination significantly increases water availability, it has potentially adverse environmental impacts in the form of greater energy consumption and subsequent increases in greenhouse gas emissions. Brine discharges to the sea can lead to substantial increases in salinity and temperature, and to the accumulation of metals (e.g. iron), hydrocarbons and toxic anti-fouling compounds in receiving waters (Roberts *et al.*, 2010). When discharges are released to poorly flushed environments, they can result in widespread alterations to community structure in seagrass, coral reef and soft-sediment ecosystems. Occurrence of the American Comb Jelly along the Mediterranean coast seems to coincide with the operation of a desalination plant (Galil *et al.*, 2009). The spread of this invasive species is of great concern because of its harmful impact on fisheries. Other concerns include the impacts of desalinated water use in agriculture, as desalination removes ions (e.g. calcium and magnesium) that are essential to plant growth. Carbonates (more than 80 mg/litre) are reintroduced into the desalinated water after completion of the desalination process. There is currently a debate regarding the addition of magnesium for health reasons.

## Box 4.1. Innovation in the water sector (cont.)

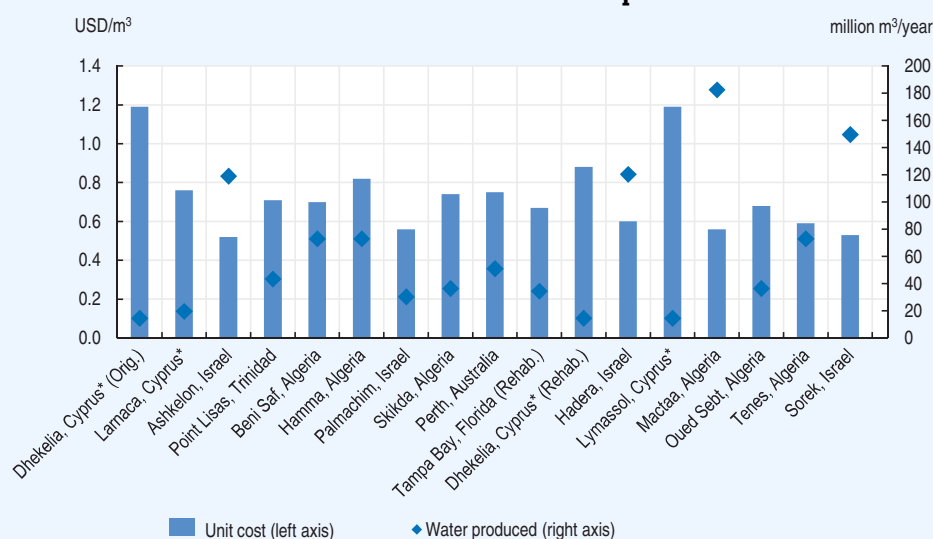
**Drip irrigation**

First developed in the 1960s, drip irrigation technology was refined in the 1980s to include innovations such as computerisation, fertigation (direct application of fertilisers to plant roots), and pressurised drippers which enable even water distribution. Recently developed sub-surface drip irrigation systems cover 5-10% of the country's irrigated area. These systems are positioned in the soil to conserve water, control weeds, minimise runoff and evaporation, increase the longevity of piping and emitters, facilitate the use of heavy equipment, and prevent human contact with low-quality water. They allow better control of environmental variables, including nutrients, salinity, oxygen and temperature. Over half of Israel's irrigated area is under drip irrigation, significantly improving water use efficiency. Drip irrigation technology also makes up a significant part of the country's water technology exports, which totalled USD 1.4 billion in 2008 (double the amount in 2005).

**Large-scale filtration of water from Lake Kinneret**

In 2007, after years of delay, Mekorot completed construction of a state-of-the-art Central Filtration Plant at Eshkol to improve water quality and reduce the turbidity of water from Lake Kinneret transported through the National Water Carrier. With an annual filtering capacity of more than 500 million m<sup>3</sup>, the filtration plant is one of the largest such facilities in the world. The decision to go ahead with the project was taken following a cost-benefit analysis, which estimated that savings in the form of avoided damage to health would be much higher than the USD 134 million spent to build the filtration plant.

Figure 4.3. **Production costs of desalinated water in large-scale seawater reverse osmosis desalination plants<sup>a</sup>**



a) The plants are ordered from left to right by operation launch date (between 1997 and 2010).

Source: Water Authority.

*\*Footnote by Turkey:* The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

*Footnote by all the European Union Member States of the OECD and the European Commission:* The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

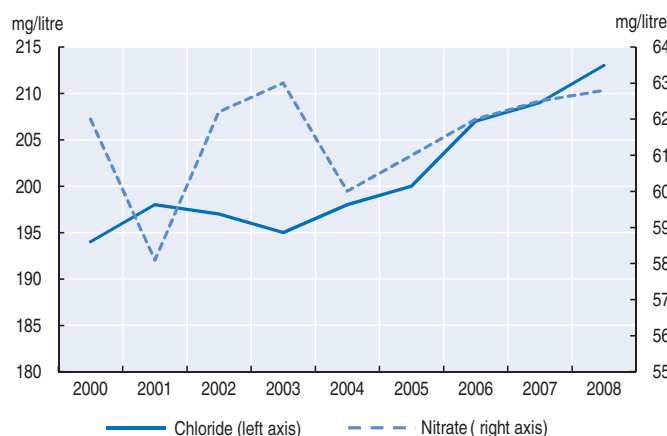
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### 3. Quality of ground and surface water

#### Groundwater

In the Coastal Aquifer, located in Israel's densely populated region, saline and nitrate concentrations have increased considerably since 2000 (Figure 4.4). Nitrate concentrations have increased from 30 to more than 60 mg/litre<sup>3</sup> in the last 60 years, mostly due to agricultural activity and the lack of tertiary treatment of increased urban wastewater. The salinity of the aquifer now exceeds 210 mg/litre<sup>4</sup> on average, due to excess groundwater pumping that generates a fall in water levels, intrusion of saline water from the sea and saline aquifers from the east (especially in the southern coastal aquifer), and high concentrations of chloride in effluent used for irrigation. In addition, 6% of the aquifer is polluted because of industrial activity occurring on top of it.

Figure 4.4. **Chloride and nitrate concentrations in the Coastal Aquifer, 2000-08**



Source: Water Authority.

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Because of the deterioration in both quantity and quality of water in the Coastal Aquifer, the Yarkon-Taninim Aquifer, a sub-basin of the Mountain Aquifer, is becoming a main supplier of drinking water in Israel.<sup>5</sup> The Yarkon-Taninim Aquifer is the only natural groundwater source whose water quality has remained acceptable. Nitrate concentrations are generally low (5-25 mg/litre); salinity ranges from 50 to 300 mg/litre, but in most (75%) pumped water it is well below 200 mg/litre.

#### Lake Kinneret

Pumping of water from Lake Kinneret is regulated. It may be carried out sparingly between 209 and 213 metres below sea level (MBSL), but is prohibited below 213 MBSL for fear it could cause irreparable damage to the lake's ecosystem and water quality.<sup>6</sup> In general, the lake has demonstrated remarkable resilience to increasing pressures in the past 30 years, as development in its catchment area has boomed. Acceptable limits have been developed based on observed variability in various chemical and biological parameters during a 25-year period (Hambright *et al.*, 2000). Nevertheless, recent events (e.g. the collapse of the Kinneret bleak fishery) indicate that the lake's natural "buffering capacity" may have been exceeded. For example, between 2000 and 2009 cyanobacteria (or

blue-green algae) often exceeded acceptable limits, particularly during the summer-autumn season (Table 4.1). The Kinneret Drainage and River Authority implemented stringent measures to reduce phosphorus discharges, the main source of the blue-green algae, particularly from the livestock sector.<sup>7</sup> Efforts have also been made to reduce the historically high salinity of Lake Kinneret (400 mg/litre), in particular through the capture and diversion of saline springs. However, salinity increased to 270-285 mg/litre in 2009-10 following several years of drought.

Table 4.1. **Water quality in Lake Kinneret, 2000-09<sup>a</sup>**

| Parameter                | Winter-spring season (January-June) |                                                           | Summer-autumn season (July-December) |                                                           |
|--------------------------|-------------------------------------|-----------------------------------------------------------|--------------------------------------|-----------------------------------------------------------|
|                          | Acceptable limit                    | Number of months beyond the acceptable limit <sup>b</sup> | Acceptable limit                     | Number of months beyond the acceptable limit <sup>b</sup> |
| Chloride                 | 243 mg/l                            | 29                                                        | 245 mg/l                             | 30                                                        |
| Cyanobacteria            | 7% of total                         | 15                                                        | 13% of total                         | 34                                                        |
| Chlorophyll <sup>c</sup> | 38 µg/l                             | 7                                                         | 10.2 µg/l                            | 12                                                        |
| Faecal coliforms         | 100/l                               | 5                                                         | 60/l                                 | 1                                                         |

a) Years 2000, 2002, and all years between 2004 and 2009 included.

b) Out of 48 months.

c) Indicator of phytoplankton blooms.

Source: MoEP.

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## Rivers

Israel has 16 main rivers flowing to the Mediterranean Sea, and 15 that flow to the Jordan River and Lake Kinneret. These rivers have been seriously depleted and polluted, although they once supported rich aquatic and wetland ecosystems. River water has been diverted for public water supply and irrigation, while untreated wastewater has been discharged to rivers. The southern Jordan River has become a relatively small stream along most of its length.

Since 2000, pollutant discharges to rivers have been reduced by 20% (total nitrogen), 40% (organic matter) and 70% (total phosphorus), largely due to the construction of new wastewater treatment plants and increasing reuse of treated domestic wastewater (effluent) in agriculture. However, despite improvements, water quality in Israel's rivers (except the still unpolluted Taninim and Zippori Rivers) needs further improvement. Rehabilitation plans have been developed for most rivers, supported by statutory planning. Water allocation plans for rivers have begun to be approved recently, with a view to ensuring adequate allocation of water for ecosystems (in terms of quality and quantity). Together with the 2010 Public Health Regulations (Effluent Quality Standards), the goal is to achieve considerable environmental improvement of rivers within five to ten years.

## Drinking water

There has been a substantial improvement in the microbiological quality of drinking water during the past two decades, with the rate of non-compliance falling from 6.5% in 1991 to 0.2% in 2008.<sup>8</sup> However, deteriorating water quality (concentrations of nitrates, chloride, micro-organisms and pesticides) has led the Ministry of Health to close 10% of the country's 2 200 drinking water wells in the last ten years. Drinking water is routinely checked for chemical (including heavy metals), physical and radiological quality.

### Coastal water

Overall, the level of pollution of Israel's coastal waters has stabilised since 2005 following a decrease in 2000-05 (Herut *et al.*, 2009). Pollution is not high with respect to international guidelines<sup>9</sup> except in Haifa Bay and at some other locations. At polluted locations, excess heavy metals, organic matter and nutrients originate from both point sources (marine outfalls and coastal rivers) and non-point ones (runoff water and atmospheric deposition).

Since 2003, the Eilat Interuniversity Institute for Marine Sciences has monitored water quality in the Gulf of Eilat/Aqaba on behalf of the MoEP. The coral reefs seem stable (*i.e.* with regard to species diversity and community structure) while concentrations of most nutrients in the water column are decreasing (Shaked and Genin, 2010). Monitoring of heavy metals started in 2009.

Large-scale desalination generates pollutant discharges to coastal waters. The MoEP has published a policy paper on the environmental impacts of desalination facilities (MoEP, 2002). The government's aim is to reduce discharges at sea of solids, suspended solids and phosphorus, and to ban those of organic material. The policy paper establishes requirements for the construction of outfall pipes, in order to reduce impacts on the marine environment, and sets parameters for marine outfalls of concentrated desalination brine. It also imposes monitoring and control of pollutants discharged at sea in concentrated brine, which should be an integral part of a desalination plant's planning and operation.

## 4. National policy objectives and international commitments

### National policy objectives

Israel has a national goal of supplying water to all consumers sustainably, based on approved requirements for quality, quantity, efficiency and economic feasibility. To this end, it has set specific targets for gradually reducing reliance on natural potable water during the coming decades, primarily to ensure security of supply, in the context of the increase in water demand (Tables 4.2 and 4.3, Figure 4.2).<sup>10</sup> These targets are designed to:

- decrease consumption by investing in technical, economic and educational means;
- increase reliability of supply (*e.g.* through increased reliance on desalinated seawater);

Table 4.2. **Water consumption indicative targets, by sector**

|      | Total consumption (all sectors)        |                                                               | Domestic consumption                      | Agricultural consumption               |                                        |
|------|----------------------------------------|---------------------------------------------------------------|-------------------------------------------|----------------------------------------|----------------------------------------|
|      | Alternative water sources <sup>a</sup> | Desalinated water (brackish and seawater desalination plants) | Per capita water consumption <sup>b</sup> | Alternative water sources <sup>c</sup> | Treated domestic wastewater (effluent) |
|      | %                                      | Million m <sup>3</sup>                                        | m <sup>3</sup> /person/year               | %                                      | Million m <sup>3</sup>                 |
| 2010 | 44                                     | 307                                                           | 90                                        | 55                                     | 400                                    |
| 2015 | 51                                     | 558                                                           | 100 <sup>d</sup>                          | 55                                     | 464                                    |
| 2020 | 57                                     | 809 <sup>e</sup>                                              | 99                                        | 58                                     | 528                                    |
| 2025 | 59                                     | 835                                                           | 98                                        | 61                                     | 587                                    |
| 2050 | 71                                     | 1 491                                                         | 95                                        | 74                                     | 900                                    |

a) Water other than natural potable water: includes desalinated, brackish and effluent.

b) Maximum desirable rate. Per capita consumption in 2010 was 90 m<sup>3</sup>/person/year.

c) Water other than potable water (both natural and desalinated): includes brackish and effluent.

d) The assumption is that per capita water consumption can increase when water sector provisions improve. The reduction to 2050 will occur in response to increasing water efficiency.

e) Of which 750 million m<sup>3</sup> of desalinated seawater supply.

Source: Water Authority Master Plan (2010).

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Table 4.3. **Water consumption indicative targets, by type of water**

|      | Natural<br>potable water<br>(%) | Desalinated<br>water<br>(%) | Treated domestic<br>wastewater (effluent)<br>(%) | Natural<br>brackish water <sup>a</sup><br>(%) | Total<br>(%) |
|------|---------------------------------|-----------------------------|--------------------------------------------------|-----------------------------------------------|--------------|
| 2010 | 56                              | 15                          | 21                                               | 8                                             | 100          |
| 2015 | 47                              | 24                          | 22                                               | 7                                             | 100          |
| 2020 | 38                              | 33                          | 23                                               | 6                                             | 100          |
| 2025 | 39                              | 32                          | 24                                               | 5                                             | 100          |
| 2050 | 28                              | 42                          | 26                                               | 4                                             | 100          |

a) Water that has more salinity than freshwater, but not as much as seawater. It may result from the mixing of seawater with fresh water, as in estuaries, or may occur in brackish fossil aquifers.

Source: Water Authority.

StatLink  <http://dx.doi.org/10.1787/888932495798>

- decrease reliance on potable water for agriculture by 150 million m<sup>3</sup> until 2050, and concomitantly increase use of treated domestic wastewater (effluent);
- upgrade all secondary wastewater treatment facilities to tertiary level by 2015;<sup>11</sup>
- increase the efficiency of water conveyance (i.e. reduce losses from leaking pipes) in all sectors, and improve the efficiency of monitoring of water consumption with automated meters.

### Major international commitments

Under the Treaty of Peace with Jordan (1994), Israel agreed to transfer to Jordan 55 million m<sup>3</sup>/year of potable water from the northern part of the country while Jordan agreed to transfer 20 million m<sup>3</sup>/year to Israel from the Yarmouk River. Thus, Israel is committed to a net supply of 35 million m<sup>3</sup>/year of potable water to Jordan (Chapter 3).

Israel notes that it has also made 88 million m<sup>3</sup>/year of water available to the Palestinians, both through direct transfers from the Israeli water system and through permits for the drilling of wells in the western Mountain Aquifer. Infrastructure projects are authorised by the Joint Water Committee established under the 1995 Israeli-Palestinian Interim Agreement on the West Bank and the Gaza Strip (the Oslo II Agreement) (Chapter 3).

## 5. Towards more efficient water use

Strong pricing signals have been introduced to encourage reduced consumption and recycling of water. However, there are different rates for the agricultural, industrial and domestic sectors (OECD, 2010b).

### Domestic sector

Measures have been taken to decrease domestic per capita water consumption from 108 m<sup>3</sup>/person/year to the current 90 m<sup>3</sup>/person/year (2010). In 2010, Israeli per capita consumption was 156 litres/head/day (lhd) for households, in the middle range of OECD countries, and 247 lhd when considering households and all other urban uses.

The main measures taken to reduce water consumption have been water-saving campaigns, increases in water tariffs, and, for 55% of households, repair of water-saving devices. Efforts have also been made to reduce pipe (conveyance) losses. Approximately 10-20% of water transported by national and urban pipelines is lost due to pipe leakages, theft and faulty metering equipment. This level of water loss compares well with good practice in other OECD countries. Israel recently decided to gradually replace most of its

manually read water meters with automated meter reading (AMR). Losses greater than 8% of the total volume of water transported must now be paid for by the Water and Sewerage Corporations. This creates an incentive for efficiency. The Corporations may also reduce water pressure in order to minimise leaks, provided they do not supply water below the minimum pressure required.<sup>12</sup>

In January 2010, tariffs for the domestic sector were raised by 40%, mainly to recover the cost of the recently built large-scale seawater desalination facilities, and as a result of the closed budget system following the establishment of the Water and Sewerage Corporations. Domestic users pay according to an increasing two-block tariff system, or progressive pricing, which encourages water conservation. Below 3.5 m<sup>3</sup>/person/month, the rate is USD 2.5/m<sup>3</sup> and, as of March 2011, USD 4/m<sup>3</sup> above this level.<sup>13</sup> In the event of exacerbated drought conditions, the addition of a third block with a much higher tariff was considered (USD 6.95/m<sup>3</sup>). It would apply to large consumers in the event of exacerbated drought conditions (this third block is known as the “drought tax”). The drought tax was initially applied in the summer 2009 as a surcharge on water prices for consumption in excess of household allocations. In response to social protest, however, this tax was frozen in early 2010 and never reintroduced.

Multimedia (television, radio, newspaper and internet) water-saving campaigns by the Water Authority have become increasingly effective, contributing to a 10% (76 million m<sup>3</sup>) reduction in domestic consumption in 2009-10 (compared to 6% in 2000-01). Greater public awareness can be attributed to several years of drought before 2009 and widespread attention to the severe depletion of Israel’s water resources (the “water crisis”) stimulated by these media campaigns.<sup>14</sup>

Since 2009, municipal parks or gardens must be equipped with water meters and municipalities are allocated a water quota for this use of water. In 2009, the quota allocated to municipal parks or gardens (20 million m<sup>3</sup>) was less than half of estimated consumption for that purpose in previous years (45 million m<sup>3</sup>).

### ***The agricultural sector***

Growth in agricultural production (20% between 2000 and 2009) has largely been achieved through improving the productivity of fixed and variable inputs, including water.<sup>15</sup> The combined effect of reducing agricultural support and tightening water quotas has been the creation of incentives to improve water use efficiency in agriculture. Demand management policies in the agricultural sector seek to accomplish two key objectives: to irrigate with non-potable water (effluent or natural brackish water) wherever possible; and to maximise efficiency in the use of irrigation water.

Three economic incentives exist to encourage farmers to switch from the use of potable water to that of alternative water sources. First, there is a price incentive: for irrigation the price of treated domestic wastewater (USD 0.34/m<sup>3</sup>) is one-third that of potable water (about USD 1/m<sup>3</sup>). There is also a quota incentive: if farmers exchange part of their annual potable water quota for reused or brackish water, an extra 20% in volume is provided free of charge. Finally, 60% of the effluent pipe infrastructure is subsidised.

Lower prices for effluent and brackish water have encouraged their use for irrigation (Table 4.4). Effluent now accounts for 40% of irrigation water against 20% in 2000, in line with the targets that had been set (Table 4.5). To meet the 2050 target of 60%, the effluent pipe grid would have to expand to cope with the increasing volume of effluent coupled with population

Table 4.4. **Water prices, January 2010**  
USD/m<sup>3</sup>

| % quota allocation | Potable water |          | Effluent | Brackish water |
|--------------------|---------------|----------|----------|----------------|
|                    | Agriculture   | Industry |          |                |
| Up to 50           | 0.496         | 1.180    | 0.226    | 0.300          |
| 50-80              | 0.571         |          |          |                |
| 80-100             | 0.724         |          |          |                |
| 100-108            | 0.887         | 1.475    | 0.282    | 0.375          |
| Above 108          | 1.049         | 1.770    | 0.338    | 0.450          |

Source: Water Authority (in Rosenthal and Katz, 2010).

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Table 4.5. **Water consumption indicative targets in agriculture, by type of water**

|      | Total<br>potable water<br>(%) | Treated domestic<br>wastewater (effluent)<br>(%) | Natural<br>brackish water<br>(%) | Total |                        |
|------|-------------------------------|--------------------------------------------------|----------------------------------|-------|------------------------|
|      |                               |                                                  |                                  | %     | Million m <sup>3</sup> |
| 2000 | 67                            | 24                                               | 9                                | 100   | 1 089                  |
| 2010 | 48                            | 38                                               | 14                               | 100   | 1 045                  |
| 2015 | 45                            | 43                                               | 12                               | 100   | 1 083                  |
| 2020 | 42                            | 47                                               | 11                               | 100   | 1 121                  |
| 2025 | 39                            | 51                                               | 10                               | 100   | 1 156                  |
| 2050 | 26                            | 67                                               | 7                                | 100   | 1 351                  |

Source: Water Authority.

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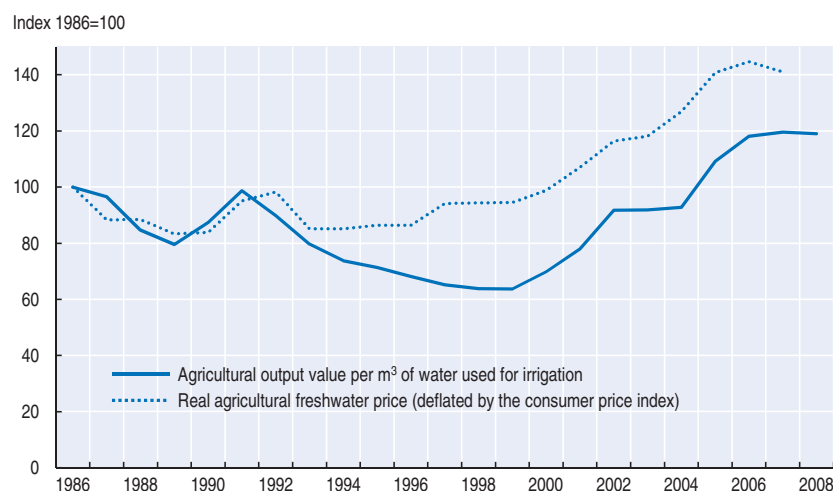
growth.<sup>16</sup> Approximately 85% of effluent is currently reused in agriculture, compared with 70% in 2000. The remaining 15% is lost through evaporation or discharged at sea.

A quota of potable water is allocated to the agricultural sector each year to create incentives for efficient water use. In 2001, following a severe drought, the quota was reduced by 23% (to 563 million m<sup>3</sup>) compared with the 2000 level. The quota has changed little since then, but it is expected to decrease to 487 and 350 million m<sup>3</sup> by 2015 and 2050, respectively (from the current 500 million m<sup>3</sup>). Quota reductions since 1999 have been compensated by income support payments.

Following a decrease in the 1990s, the value of output per unit of water used for irrigation significantly improved in the 2000s (Figure 4.5). During the last decade, water use declined from 7 megalitres (ML)<sup>17</sup> per hectare per year to about 5 ML/ha/year. This is largely due to technological improvements (i.e. the introduction of new irrigation technologies and irrigation management practices, increased cultivation of crops requiring less water) and water policy reform (e.g. increases in average real agricultural water prices). Compared with Israel's current rate of water use in irrigated agriculture of around 5 ML/ha, the OECD 2002-04 average was 7.5 ML/ha (OECD, 2010c).

While water pricing in the domestic sector was established by the Water Authority to cover the cost of production (USD 2/m<sup>3</sup>), water use in the agricultural sector is still heavily subsidised (above the quota price of around USD 1/m<sup>3</sup>). The government's objective is to gradually charge farmers for the social costs or "true resource value" of water (by 2015). The calculation of such external costs is not a simple task and is a major challenge in Israel's efforts to achieve the integrated management of its water resources (Kedmi, 2005). The pace of the price increase will take account of the agricultural sector's capacity to further increase its already high water use efficiency. By 2050, the volumes of domestic water

Figure 4.5. **Economic efficiency of agricultural water use, 1986-2008**



Source: OECD (2010), *OECD Review of Agricultural Policies: Israel, 2010*.

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consumption and agricultural water consumption (all water types combined) are expected to be approximately equal (agricultural water consumption is currently 50% higher in volume) (Figure 4.2). The 2006 Farmers' Agreement commits the agricultural sector to an increase in the price of water to recover the costs of production by 2015.

Support to agriculture, expressed as a percentage of gross farm receipts,<sup>18</sup> decreased from 24% in 1995-97 to 17% in 2006-08, below the OECD average of 23% (OECD, 2010a). However, the most distorting forms of support (based on commodity output and variable input use) still dominate (96% of PSE in 2006-08). Budgetary expenditure on agri-environmental measures (USD 9 million in 2008)<sup>19</sup> is just over 2% of total agricultural budgetary expenditure.

### Industry

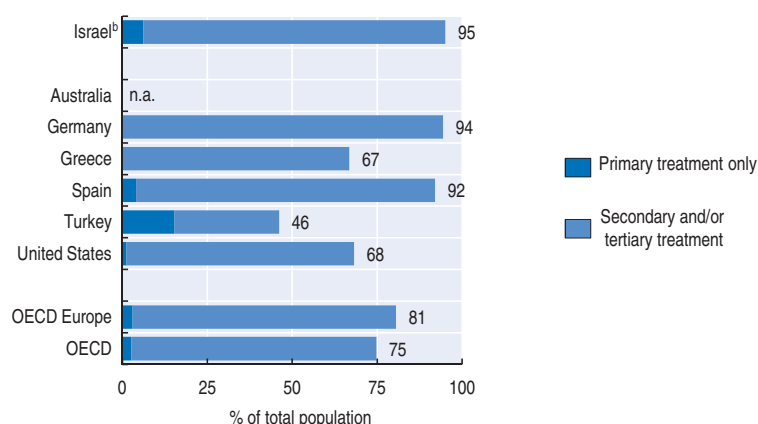
As in the case of agriculture, price incentives are provided to industry to use alternatives to potable water (Table 4.4). These incentives have not been as effective as in the agricultural sector: about 25% of water consumed in the industrial sector (30 million m<sup>3</sup>) was brackish in 2010. A new policy is being sought to increase the use of effluent by industry, which could take the form of grants to invest in on-site wastewater treatment plants.

As in the agricultural sector, efficiency of water use in the industrial sector is controlled by a quota system. Water use by industrial users is also subsidised, although much less than in the agricultural sector (above the quota price of USD 1.8/m<sup>3</sup>). The government's objective is again gradually to charge industry for the cost of supplying water by 2050.

## 6. Towards more efficient water quality management

Most (93%) of Israel's population is connected to public wastewater treatment plants, a very high rate by OECD standards (Figure 4.6). The ultimate goal is to treat almost 100% of wastewater to a level enabling its unrestricted use in irrigation (i.e. without risk of over-nutrition to soil and water sources). To achieve this, Israel plans to upgrade all existing

Figure 4.6. **Population connected to public wastewater treatment plants, 2009<sup>a</sup>**



a) Or latest available year.

b) Includes population served by other wastewater treatment (1.7%) and population whose wastewater is transported by truck from independent storage to wastewater treatment plants (0.2%).

Source: OECD, Environment Directorate.

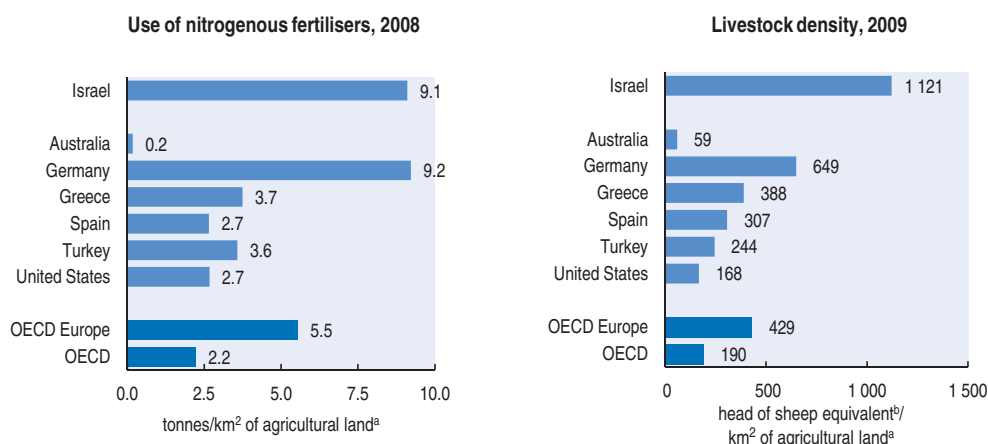
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secondary-level treatment facilities to at least tertiary level between 2010 and 2015, and to reuse as much effluent as possible for irrigation.

Most treatment plants now provide intensive treatment (i.e. they treat flows above 1 400 m<sup>3</sup>/day) and generate high-quality effluents. In 2009, 92% of effluents complied with national standards.<sup>20</sup> From 2010, new standards require effluent quality to comply with 36 parameters, including chloride concentrations. High chloride concentrations (salt concentrations) in effluent used for irrigation have been responsible for soil and groundwater contamination, especially in the Jezreel Valley and on the coastal plain. The widespread introduction of desalination will improve effluent quality by reducing saline concentrations, thereby reducing pressure on aquifers from effluent used for irrigation. This is already evident in the south of the country, following the introduction of large-scale desalination plants at Ashkelon, Palmachim and Hadera. However, the increase in desalinated seawater, together with the development of the water transport infrastructure, represents an expansion in the use of energy-intensive forms of water supply.

Effluent discharge to rivers is prohibited under the Water Law, although permits may be granted on a case-by-case basis by an advisory committee grouping the Water Authority, the MoEP and the Ministry of Health. The permits must comply with the 2010 Public Health Regulations (Effluent Quality Standards). The list of discharge permits was made publicly accessible as of 2009, including the name of the permit holder, date of issuance, expiry date, and date of denial if the permit was not granted.

Concerning the impact of agriculture on water quality, it is not clear whether the national nitrogen and phosphorus balances have evolved over the last decade, during which the number of livestock increased while inorganic fertiliser use decreased (OECD, 2010a). Israel's livestock density is high by OECD standards (Figure 4.7), as is the intensity of its use of nitrogen fertilisers (Figure 4.7). Fertiliser use has decreased due to more efficient application methods (e.g. fertigation) and greater use of effluent (which contains plant nutrients).

Figure 4.7. **Agricultural inputs and livestock density**

a) Arable area, permanent crop land and permanent grassland.

b) Based on equivalent coefficients in terms of manure: 1 horse = 4.8 sheep; 1 pig = 1 goat = 1 sheep; 1 hen = 0.1 sheep; 1 cow = 6 sheep.

Source: FAO (2010), FAOSTAT Database.

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The only currently available information on national agricultural pesticide use dates to 1998,<sup>21</sup> when average intensity of use was 0.01 tonnes/km<sup>2</sup> of agricultural land. This is low by OECD standards. Pesticide concentrations in the Kinneret watershed are low. In northern Israel, however, intensity of pesticide use (0.07 tonnes/km<sup>2</sup>) is more in line with the OECD average. In 2007-08, one or more pesticides were detected at around 35% of the Water Authority's monitoring sites in coastal aquifers, although none had pesticide concentrations exceeding Israeli drinking water standards. There is some evidence that pesticide use has begun to decline in response to wider adoption of Integrated Pest Management (IPM)<sup>22</sup> and the need to meet the pesticide residue standards of the European Union, a key export market for Israel's horticultural products. Organic agriculture has increased, but it still accounts for less than 2% of agricultural land. A national biological pest control project was initiated in 2007, using barn owls and kestrels.

## 7. Water and nature management

Since 1993, the MoEP's River Restoration Administration (RRA), together with the Keren Kayemeth LeIsrael-Jewish National Fund and other bodies, has administered the rehabilitation of Israel's rivers. This requires complex planning and co-ordination between different stakeholders (e.g. government ministries, local authorities, the private sector and NGOs).

River rehabilitation plans address ecological, hydrological and recreational aspects. This includes restoration of natural ecosystems alongside rivers, preservation of aquatic biodiversity, pollution prevention (e.g. enforcing the ban on effluent discharges to rivers), water resource management (e.g. restoration of flow paths), enhancing the ability of rivers to serve as drainage channels for flood control (e.g. cleanup of riverbeds), and promotion of the use of rivers for leisure activities and tourism.

The river rehabilitation plans are based on a river basin management approach. They are implemented on different levels, from specific sections of rivers to entire drainage basins. The RRA serves as a catalyst for implementation of these plans, particularly through funding the 30 regional river administrations, which group local authorities, drainage authorities, regional organisations and NGOs as well as an RRA representative.

Studies have been carried out on the economic feasibility of river rehabilitation projects. Cost-benefit analyses conducted for numerous rivers have demonstrated that rehabilitated rivers and adjacent parks contribute to the economic growth of localities by attracting private investment and increasing real estate values (MoEP, 2010).

In 2000, the government decided that some 50 million m<sup>3</sup> per year of water should be allocated to nature as part of its overall water allocation policy. As of 2010, the allocation of water provisions to nature has been raised to 60 million m<sup>3</sup> per year, including 10 million m<sup>3</sup> of potable water and 50 million m<sup>3</sup> of treated effluent. This allocation is targeted to increase to 95 million m<sup>3</sup> per year by 2020. In 2003, the NPA assessed the water requirements of nature and the landscape in Israel. This policy document called for a change in Israel's approach to water management, with a view to preserving existing nature and landscape values and rehabilitating those which have disappeared (MoEP, 2003). Article 6 of the Water Law was amended in 2004 to introduce the "right of nature to water". This article now refers to the need to provide "water for the conservation and rehabilitation of natural assets and landscapes, including rivers, springs and wetlands". As part of the master plan developed by the Water Authority, the MoEP and the NPA, water for nature values will be defined. The MoEP is currently promoting mapping and the preparation of detailed plans for rivers, in accordance with their specific ecological systems' requirements.

## 8. Expenditure on and financing of water management

### Public expenditure

In 2010, Israel spent nearly USD 580 million on sewerage and wastewater treatment, including both investments and operation and maintenance (Table 4.6). Expenditure is expected to increase to some USD 1 billion/year between 2011 and 2020, in order to finance the upgrade of all wastewater treatment facilities to at least tertiary level as well as the construction of new and expanded wastewater treatment facilities.

Table 4.6. **Public expenditure on wastewater treatment,<sup>a</sup> 2010-20**

|                                        | USD million/year |              |              |                    |
|----------------------------------------|------------------|--------------|--------------|--------------------|
|                                        | 2010             | 2011-15      | 2016-20      | USD/m <sup>3</sup> |
| Sewerage                               | 215              | 223          | 244          | 0.45               |
| Sewage treatment                       | 356              | 424          | 452          | 0.71               |
| Upgrade to tertiary level <sup>b</sup> |                  | 26           |              | 0.06               |
| New sewerage                           |                  | 202          | 202          | 3.37               |
| New sewage treatment                   |                  | 219          | 92           | 3.11               |
| Sludge treatment                       | 6                | 6            | 6            | 236.00             |
| <i>Sub-total</i>                       | <i>577</i>       | <i>1 100</i> | <i>996</i>   |                    |
| Effluent pipe grid                     | 113              | 135          | 144          | 0.23               |
| <b>Total</b>                           | <b>690</b>       | <b>1 235</b> | <b>1 140</b> |                    |

a) Cost estimates are based on 2010 market prices and do not include any potential future innovations for improved efficiency. These reported costs are approximations. The true costs vary within and between municipalities, according to differences in fees incurred per project in the tender-bidding process.

b) Completion is planned for 2015.

Source: MoEP, Water Authority.

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In addition, in 2010 around USD 110 million was spent on expanding the effluent pipe grid to increase the proportion of effluent that can be reused in irrigation. This expenditure is expected to increase to USD 140 million/year by 2020 in order to bring the increasing

volume of effluent coupled with population growth to the irrigation pipe grid (Table 4.6). Support to effluent pipe infrastructure began in the 1980s, first for the construction of reservoirs to collect storm water and later to bring more effluent to farmland.

In addition to the support to the effluent pipe grid, budgetary support to water management in agriculture is also provided for on-farm irrigation; water price support has been provided by Mekorot; and, between 1999 and 2004, there was compensation for cuts in water quota allocation (Table 4.7). Support to on-farm irrigation consists mainly in investment grants for installing drip irrigation and other water-efficient technologies. The government also covers part of the costs (both operational and maintenance and fixed capital) of Mekorot's supply of freshwater to agriculture. Further reduction of the quota will be compensated if farmers can present evidence that they have invested in water-saving technologies.

Table 4.7. **Government support to water management in agriculture, 1995-2010**

|                                               | USD million |      |      |      |
|-----------------------------------------------|-------------|------|------|------|
|                                               | 1995        | 2000 | 2005 | 2010 |
| Water price support                           | 164         | 50   | 7    | 19   |
| Compensation for water quota cut <sup>a</sup> | –           | 4    | –    | –    |
| Farmers' Agreement <sup>b</sup>               | –           | –    | –    | 27   |
| Water extraction levy concession <sup>c</sup> | –           | 29   | 24   | 13   |
| Investment in water projects (on-farm)        | 2           | 2    | 12   | 71   |
| Total                                         | 166         | 85   | 42   | 130  |

a) Implemented in the period 1999-2004.

b) Since 2006.

c) Since 2000.

Source: OECD, PSE/CSE Database.

StatLink  <http://dx.doi.org/10.1787/888932495874>

In 2005-10, the MoEP allocated USD 5 million per year to the rehabilitation of polluted rivers.<sup>23</sup> This is much less than provisions in the 15-year national plan for river rehabilitation (2005-20), which estimated the cost of the ecological and landscape rehabilitation of rivers at USD 35 million/year (and the total cost of river rehabilitation at USD 67 million/year). River rehabilitation is mostly funded by the MoEP, with matching funds from the Keren Kayemeth LeIsrael-Jewish National Fund (KKL-JNF). Monitoring of aquifers and of Lake Kinneret is financed by the Water Authority, while the MoEP finances monitoring of rivers and marine waters.

Around USD 3 million/year is spent on monitoring water quantity and quality, of which 55% on aquifers, 20% on the Lake Kinneret watershed, and 25% on rivers and marine waters.

### Financing through tariffs

The Water Authority is responsible for designing tariff levels and their structure to recover supply costs and reflect scarcity. Charges for all water in Israel are determined according to the volume metered. Prices for consumers are the same in all regions. Municipalities are subject to fines if unbilled water quantities exceed 12% of the water consumed by the local authority.

Israel has achieved full recovery of the costs of supplying water services. However, about 35% of agricultural uses of potable and reused water are still cross-subsidised by the household sector and receive a relatively large share of public support. Following a 2006 agreement between the government and farmers, it is expected that by 2017 the

agricultural sector will pay the average cost of water production (operation and maintenance and fixed capital costs). The agreement to move towards charging farmers the average cost of water production implies a gradual elimination of water price support by Mekerot and the end of urban/industrial cross-subsidisation of water for agriculture. Water price support by Mekerot will only be provided during this period on condition that farmers invest in water-saving technologies and infrastructure, so that they can adjust to the increase in water charges by 2015 (OECD, 2010a).

Wastewater tariffs based on water consumption are charged by local authorities and included in the water bill (i.e. a combined water bill). They are planned so as to recover the cost of producing effluent to a quality level enabling unrestricted irrigation, or investment and maintenance related to the effluent pipe grid. To finance investments in wastewater treatment, municipalities receive grants and soft loans through various funds including the National Sewage Fund.

### **Green taxation of water**

A water extraction levy is imposed on domestic, industrial and agricultural consumers. It partly reflects the scarcity value of water resources, with a higher rate charged for the extraction of groundwater than for that of surface water (OECD, 2010a). However, farmers benefit from concessions (Table 4.7). Extending the levy to water producers is envisaged, in order to fully reflect the environmental cost of water and prevent depletion of aquifers. The levy on water producers would be differentiated according to natural resource conditions and water quality, water quantity, and location of the catchment. A marine pollution levy has also been proposed, which would apply to discharges of sewage and other waste streams to seawater, but not to discharges to rivers. The marine pollution levy (not in force yet) is awaiting approval by the Knesset.

### **Notes**

1. The Coastal Aquifer is a phreatic aquifer extending some 120 km along Israel's Mediterranean coastline.
2. The water that flows downstream is only saline water and effluent. Occasionally, water flows from Lake Kinneret.
3. Water with a nitrate concentration higher than 50 mg/litre is not potable.
4. There is no limit on the salinity of potable water. Chlorides are essential to the human organism, as they play an important role with regard to the cell structure. However, according to the WHO, chloride concentrations above 250 ppm could affect the taste of drinking water.
5. Like the Coastal Aquifer, it supplies a quarter of national drinking water requirements.
6. Water levels in the lake, fluctuating in accordance with its use in the national water system and the amount of precipitation and inflow, have varied between 213 and 209 metres below sea level for several decades.
7. For example, manure from local cattle is collected, transported and treated in a sewage treatment facility. All cowsheds must be covered in the winter (rainy) season, so that rain does not wash the manure into the lake. Food and water for cattle are located away from streams in all watershed pastures.
8. Bacteriological standards, tightened in 1989, state that water is unfit for drinking if it contains more than three coliform microbes and/or one faecal coliform per 100 millilitres (ml). This is less stringent than the EU standard of zero *Escherichia coli* per 100 ml.
9. Guidelines of the MED POL Programme, the marine pollution assessment and control component of the UNEP Mediterranean Action Plan for the Barcelona Convention, to which Israel is a contracting party.

10. According to the Master Plan for Water Sector Development in the period 2010-50.
11. Secondary treatment removes biological matter, employing micro-organisms, while more advanced (tertiary) treatment involves chemical processes to remove non-biodegradable toxic organic pollutants, nitrogen and phosphate.
12. Reduction of water pressure was initiated in 2009 in many municipalities, where it is expected to reduce municipal water consumption by about 5%.
13. In March 2011, following a public outcry about increases in the prices of many items across the economy, the first block was increased from 2.5 to 3.5 m<sup>3</sup>/person/month.
14. The extremely low water level in Lake Kinneret was used as a prominent symbol of the water crisis.
15. Some 60% of Israel's agricultural land is irrigated.
16. Some wastewater treatment plants are not yet connected to the irrigation pipe infrastructure.
17. One megalitre is 1 million litres.
18. As measured by the Producer Support Estimate (PSE).
19. Including USD 3 million/year to encourage the adoption of Integrated Pest Management (IPM).
20. Until 2010, regulations called for (secondary) treatment of wastewater to a minimum baseline level of 20 mg/litre biological oxygen demand (BOD) and 30 mg/litre suspended solids in every settlement with a population exceeding 10 000 people.
21. Survey carried out jointly by the MoEP and the Central Bureau of Statistics.
22. IPM is used to eradicate the Mediterranean fruit fly. Its use has become widespread in the production of strawberries (on 90% of the crop area), avocado and mango (80%), citrus crops (65%) and peppers (50%).
23. This is in addition to expenditure on wastewater treatment, including reuse of effluent in irrigation, which also contributes to the improvement of river quality by reducing sewage discharges to rivers.

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