Dealing with Prolonged Drought & Water Scarcity: Water policy reforms that took Israel from a water scarce to a water abundant nation

Ariel Dinar
Professor of Environmental Economics and Policy
School of Public Policy
University of California Riverside

Slides marked with “CH” are courtesy of Professor Haim Gvirtzman, The Hebrew University of Jerusalem. His help is much appreciated.
Plan of talk (40 min)

- Geography and size
- Physical characteristics
- History of water issues (quantity and quality)
- The policy debate
- The basis for the reform
- The reform and its outcome
Israel and California: Similarities and Differences
How water scarcity is measured?

Water amount is fixed (more or less)

Amount of available water is FIXED:

- World 28,340 billion acre-feet
- California 35 million acre-feet
- Israel 1.2 million acre-feet

1 af = 1235 cubic meter
California faces similar trends as Israel, and is even in better shape.

1AF = 1235 cubic meters

Cubic meters per capita per year

Availability of Freshwater in 2000
Average River Flows and Groundwater Recharge

Countries with the least freshwater resources
- Egypt: 26
- United Arab Emirates: 81

Countries with the most freshwater resources
- Suriname: 479,000
- Iceland: 605,000

Rainfall distribution in Israel (mm) 1900-2012

1 inch = 25.4 mm

Total Annual ≈ 300mm ≈ 12 inch
Main Surface and groundwater sources
Increasing groundwater salinity

Local-Regional pollution

Rising salinity and nitrates over time
Replenishment Data (Three Basin System)

1932-2009

Cumulative shortages associated with sequences of dry years require reliable additional supply
Early projects and plans

• Massive investment in freshwater conveyance
• Massive investment in wastewater treatment
• Investment in water harvesting

• Yet, water quality and quantity prevail
Israeli Water System:
Many sources, One long pipe.
National Water Carrier 1960s
SHAFDAN 1970s
Floodwater harvesting ponds
Plans for New desalinization schemes

Development of Sea Water Desalination Plants

Sea Water Desalination Projects

- Under construction
- Tender
- Planning

- Shomrat 30 MCM
- Hadera 100 MCM
- Shafdan up to 200 MCM
- Palmakhim 30 MCM
- Ashdod 45 MCM
- Ashkelon 100 MCM

Construction phase: Production at 10/09
Decentralization of responsibility

The "method" of mutual neutralization

No decision making due to the lack of a single executive officer
The environmental/health cost

Nitrates and Chlorides Concentrations in the Coastal Aquifer 1970-2005

- Chloride
- Nitrate

<table>
<thead>
<tr>
<th>Year</th>
<th>Cl^- (mg/l)</th>
<th>NO3^- (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>1975</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>1980</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>1985</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>1990</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>1995</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>2000</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>2005</td>
<td>75</td>
<td>75</td>
</tr>
</tbody>
</table>
Water table dropping
Groundwater salination

- Izre’el valley salination
- Na’aman salination
- Arava aquifer salination
Not enough Infrastructure to store water from rainy years to dry years
Salination and contamination

Seawater intrusion, leaks of sewage, sewage effluent irrigation, insecticides, fertilizers, landfills, oil lens, toxic metals, micro-pollutants, etc.
Lake Kineret
Parliament’s State Control Committee (2000)

“The report revealed a water system in a most serious state. Most of the severe findings detailed in the State Comptroller's Annual Report of 1987, and in the Special Report of 1990 on water economy management, are still valid today. These reports failed to bring any government to serious discussion or decisions, and the situation continued to deteriorate. We are currently in a state of emergency. If no decisions are made, no policy defined, and no drastic steps taken in the near future, Israel’s water economy will face the danger of collapse.”

- Lack of national policy
- No responsible authority
- No water reserves
- Over pumping

- Water contamination
- Sewage re-use
- Agriculture
- Political process
Policy Reform

• Institutional reform
• Investment in technology
  – Desalination
  – Treatment
  – Control
• Investments in infrastructure
• Pricing (all sectors)
• Public campaign (conservation)
• Transparency
  – Periodical water prices updates
  – Periodical water quality test results reporting
Getting out of the water crisis since 2000

- Establishing the Water Authority
- Increasing water price (+40%)
- Entering the desalination era
- Recycling full sewage potential
- Water allocation for nature
- Restoring aquifer storage
- Water & Sewage Corporations Law
Water Authority Board

ONE table for decision making

- Chairman, Water Authority
- Member, Public Representative
- Member, Ministry of Finance
- Member, Ministry of Environment
- Member, Ministry of Interior
- Member, Ministry of Agriculture
- Member, Ministry of Energy & Water

Plan, Develop, Manage, Supply, Regulate
June 15, 2015 announcement of new water tariffs (a rate reduction!)

Water price update = f(CPI (85%), Salary index (10%), Energy index (5%))
Exchange rate=3.83 IS/$ 1af=1235 cubic meters

- Fresh water for ag $754/af
- SAFDAN WW for ag $354/af
- Any WW for unrestricted use $354/af
- Secondary WW $299/af
- Fresh for household use (base amount) $670/af
- Fresh water for household use (above base amount) $1929/af

Source: YEVUL SEE, 108(42) June 2015
# Evolution of Desalination Capacity

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td># facilities</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Water produced (MCM)</td>
<td>152</td>
<td>267</td>
<td>291</td>
<td>310</td>
<td>359</td>
<td>350</td>
<td>550</td>
</tr>
</tbody>
</table>

Source: Water Sector Budget 2015
Sea Water Desalination

Completed facilities
- Ashkelon - BOT 120 MCM/Y (VID)
- Palmachim - BOO 90 MCM/Y (Via Maris)
- Hadera - BOT 127 MCM/Y (H$_2$ID)
- Sorek - BOT 150 MCM/Y (SDL)

Under Construction
- Ashdod - 100 MCM/Y (TK Mekorot)

About 10 MCM/Y brackish groundwater

2015: 600 MCM/Y
2020: 750 MCM/Y
Agriculture irrigation sources

- **Potable**
- **Effluent**
- **Brackish**

Year:
- 1960
- 1965
- 1970
- 1975
- 1980
- 1985
- 1990
- 1995
- 2000
- 2005
- 2010
- 2015
- 2020
- 2025
- 2030
- 2035
- 2040
- 2045
- 2050

MCM/yr:
- 0
- 200
- 400
- 600
- 800
- 1000
- 1200
- 1400
- 1600

- 144 (14%)
- 400 (38%)
- 500 (48%)
- 350 (26%)
- 900 (67%)

- 2050
Reuse of All Sewage Effluents

Irrigation with recycled effluents of Dan Region
130 MCM/Y
Expansion of irrigated land
Reducing water demand

- Guidance through a media campaign.
- Enforcement regarding public parks irrigation.
- Increase in water rates.
- Water saving devices.
Water Consumption by Sector 1950-2008

Irrigation Water Use and Agricultural Production

Restoring water storage

Elevation (m)

Time (year)

Upper Red Line -208.80
Lower Red Line -213.00
Black Line -214.87

16.03.2014 -211.03
Municipal Water Sector

Investment deficit of 10 billion shekels

Legislation Water-Sewage Corporations Law

By 2014, 55 Corporation were established, serving about 6.2 million citizens (out of 8.0 million).

Achievements:
- Reducing water loss.
- Increasing current collection.
- Increased investments in infrastructure.
- Implementation of new technologies.
Water tariffs – Domestic sector

Two-block tariff system:

1 cubic meter ≈ 250 gallons ≈ 2.5 CCF

- Below 3.5 m³/person/month - the rate is USD 2.5/m³
- Above 3.5 m³/person/month - the rate is USD 4/m³

- Progressive pricing
- Encouraging conservation
- Cost recovery
How much we pay for water in household use?

Israel
- Israel water company MEKOROT (wholesaler) charges $1.374/cubic meter ($1696.8/acre foot)
- Municipalities charge $3.460/cubic meter ($4273/Acre foot)

Riverside
- In April I paid an average of $2/CCF ($871.2/acre foot)

Water in IL for household use is 4 times more costly to users than in Riverside
Demand Management: Impact of domestic water pricing on consumption


Additional future steps

• Further reforms in water tariffs
• Water allocation for nature
• Master plan (up to 2050)
• Export (sell) water to neighbors