ALBERT MAINERD SCHOLARSHIP - STUDY TOUR OF ISRAEL

Daryl McGregor, dmcgregor@alburycity.nsw.gov.au
Manager Albury Water, City of Albury, NSW, Australia

Abstract

Daryl McGregor was the 2001 recipient of the Albert Mainerd Scholarship, a study scholarship awarded by the Local Government and Shires Associations of NSW. The Scholarship is awarded annually and rotated among the five professional staff organisations in Local Government. The 2001 Award was only available to members of the IPWEA.

Mr McGregor's topic was Water Resource Management in Israel addressing the specific areas of water conservation, salinity management and algae control.

This paper outlines details of the study tour, which was undertaken in March 2002 and summarises the findings relevant to water resource management in Australia.

Key Words: Israel, water conservation, salinity, blue-green algae, irrigation, aquifer recharge

Introduction

The author was fortunate enough to be the recipient of the 2001 Albert Mainerd Scholarship - to study water resource management issues in Israel. The issues specifically investigated include:-

- Water conservation strategies
- Salinity management initiatives
- Blue-green algae control processes
- Management of water

All these issues are intrinsically linked and relate to the way we use water.

This paper summarises the results of the Study Tour, which was undertaken in March this year and discusses the applicability of initiatives to Australian conditions.

Background

Geography and Topography

Israel is part of the Asian continent, bounded to the west by the Mediterranean Sea, to the north by Syria and Jordan, to the east by Jordan and to the south by Egypt.

The total land area of Israel (including the Palestinean territories of the West Bank and the Gaza Strip) is 25,970 square kilometres (less than half the size of Tasmania!).

Israel's topography is dominated by the Rift Valley, which is part of the Syrian-African Rift (the longest valley in the world). The Rift Valley runs along the eastern border of Israel - from the mountains of the Golan Heights to the Sea of Galilee, along the Jordan River Valley to the Dead Sea and into the arid south via the Arava Valley.

The primary surface water source is the Sea of Galilee (Lake Kinneret) and the Jordan River. The Jordan River eventually discharges into the Dead Sea, which is the lowest area on earth at 386 metres below sea level.

The Dead Sea is flanked by the Jordan Desert where in the south it joins with the Negev Desert.

Politics and Economy

Israel is a secular, parliamentry, democratic republic with a President as Head of State. The Knesset is the parliament, comprising 120 members drawn from about a dozen political parties. The two major parties are the Labor Party and the Likud Party.

Following independence in 1948, the Country grew rapidly whilst relying on injections of cash and aid from overseas. Agricultural development and military expansion dominated expenditure until the late 1980's. Subsequently, post 1985, the economy has shifted from an agricultural base to a post-industrial economy with major expansion of industries like chemicals, minerals, plastics, electronics and military technology. Israel has now become a world leader in a number of high-tech areas, including computer technology and agricultural genetics.

Population

The total population of Israel, including the Palestinean Territories is approximately 8.0 million. The Arab population in the West Bank and Gaza Strip is about 1.5 million.

The demographic makeup is reported as 80% Jews, 15% Muslims, 2% Christians and 1.5% Druze. There are also minority groups of Asians and Samaritans.

In the south of the Country (in the Negev) an estimated 80,000 - 100,000 Bedouins still remain with a small percentage pursuing a nomadic or semi-nomadic existence.

Water Resource Management in Israel

Background

Generally speaking, Israel is a dry land country with much of the land mass classified as desert. Rainfall varies from in excess of 800 mm per year in the north of the country, to less than 50 mm per year in the south. (Refer Figure 1: Appendix A)

Most of the Country is classified as arid (60%), with most of the remainder semi-arid. The dry season falls between April and October and little if any rain falls in this period.

The only surface water source in Israel is the Jordan River and, in particular, Lake Kinneret. Early development of the country, therefore, was concentrated in the north, along the Jordan (north of the Dead Sea) and along the Mediterranean Coast.

Water Resource Development

Population growth and development in Israel followed two significant events. The first wave of migration occurred following the establishment of the British Mandate at the end of the First World War when many Jewish immigrants arrived in the, then, Palestine (many from Europe). The second major wave of immigration occurred after the Second World War and particularly post - 1948 when the State of Israel was created. A third wave of immigration, mostly from Russia, has occurred over the past 15 years, resulting in over 2 million migrants settling in Israel.

The population is expected to grow to nearly 9.0 million by 2020. Including the Arab population in the West Bank and the Gaza Strip, the total population served by water supplies will probably

be about 12.0 million people in twenty years time. This will not only cause substantial increases in urban demand for water, but it is anticipated that agricultural demands will also increase dramatically.

The first major effort to build a large scale water supply scheme (to supply water throughout Israel and particularly south to the Negev Desert) began in 1935. The source of supply was wells in the Ysrael (Jezreel) Valley conveyed in large pipes.

Settlement of the Negev Desert commenced in 1943 with three experimental settlements. Eleven more were established in 1946 and a further five in 1947.

The first pipeline to the Negev was constructed in 1947 (190 kms of 150 mm diameter pipes supplied from groundwater wells in the north-western Negev).

The first large scale system was a 66 inch pipeline from the Yarkon River to the Negev. This pipeline was 130 kms in length and was capable of supplying 100 x 10^6 m^3/yr. It was constructed immediately after the creation of the State of Israel in 1948.

The National Water Carrier was completed in 1964 supplying water from Lake Kinneret throughout the country, culminating in the Negev, near Beer Sheva. The Carrier is a combination of pipelines, channels, reservoirs, tunnels and local storages, supplying around 400 x 10^6 m^3/yr.

The water is pumped from Lake Kinneret to an elevation of 152 metres above sea level (Kinneret is about 220 metres below sea level). It then flows by gravity to the coastal region and is then pumped, in stages, to the Negev.

Two large aquifers (the Mountain Aquifer in the north; and the Coastal Aquifer) supplement supply to the National Carrier. The Coastal Aquifer contributes approximately 250 x 10^6 m^3/yr.

A plethora of wells along the route of the National Carrier also supply groundwater into the system, as required. (Details of the National Carrier are shown in Figure 2: Appendix B)

Current and Future Water Resource Development

Freshwater sources of water in Israel have now been almost fully exploited.

Reliance is now being placed on re-use of sewage effluents and (in the future) desalination of both sea water and sewage effluents.

The Shafdan Plant in Tel Aviv has led the way in re-use of sewage effluents on a large scale.

Wastewater from a regional population of 1.3 million people is treated and then discharged into adjacent aquifers. This water is then transferred to the Negev in the "Third Negev Pipeline" for use in irrigation of agriculture in the western Negev. On a smaller scale, plants in the Negev itself provide effluent for local agricultural pursuits.

Desalination of Mediterranean Sea water will be a reality in 2 years time, with the construction at Ashkelon of a 50 x 10^6 m^3/yr Reverse Osmosis Plant.

Uses of Saline Water for Agriculture

Saline water has been found to be suitable for irrigating a range of agricultural produce. Water with EC's of more than 7000 μS/ml has been successfully used to irrigate tomatoes, melons, cotton and alfalfa, subject to controlled use via drip irrigation and subject to cultivation in mediums other than soil or in sandy, sandy/loam soils (plentiful in the Negev!).

Issues of Interest

Desalinisation

Israel is about to embark on the construction of two desalinisation plants, each of 50 x 10^6 m^3/yr capacity. The cost to produce water via desalinisation has become affordable at 52.7 US cents per m^3 and expectations are that the desalinisation program will expand to a capacity of 500 - 600 x 10^6 m^3/yr within 10 years.

Desalinisation processes will concentrate on sea water initially, but it is also proposed that desalinisation of treated sewage effluents be fully investigated.

Use of Reclaimed Sewage Effluents

Currently, Israel uses approximately 250 to 300 x 10^6 m^3/yr of reclaimed sewage effluents, principally to augment supplies for agricultural irrigation. The use of reclaimed water for agricultural purposes, aquifer recharge and even urban purposes is expected to increase markedly in the near future.

The use of membrane filtration to ensure safe water for a range of uses is also expected to be actively pursued.

Water Use Efficiency and Water Conservation

Water conservation and water use efficiency are extremely important to water resource management in Israel. These objectives are being achieved through realistic water pricing, community education and awareness, advances in irrigation technology and revolutionary agricultural practices.

Urban prices for water vary between A$2.10 per kilolitre to A$3.00 per kilolitre as base costs. Factoring in charges for infrastructure improvements and local area salaries and overheads, the average cost to all urban consumers is typically A$600 per annum (or more) for an average consumption of approximately 200 kilolitres per year.

Watering of urban "gardens" is restricted to drip irrigation and the majority of landscape plants are local, native, water efficient and salt tolerant plants. Lawns and garden beds are almost non-existent in Israel.

Agricultural irrigation is almost entirely dominated by drip irrigation. Increasingly, irrigation is sub-surface, micro-drip irrigation and this coupled with increasing use of hot houses/green houses and fertigation (focussing on the increased use of potassium chloride) is ensuring optimum water use efficiency.

Irrigation with Saline Water

Increasingly, the use of saline water (up to 9000EC) is being used to irrigate crops, particularly in the dry, desert areas of the Negev. Crops such as tomatoes, melons, olives, flowers, cotton and alfalfa are drip irrigated with saline water. Not only is yield the same as irrigation with fresh water, in many instances the product is better quality. "Sweet" tomatoes, for example, grown with saline water of up to 3000EC, fetch 3-4 times the price of "normal" tomatoes in European markets. Alfalfa crops grown with saline water yield 18% protein, compared to 14% in crops grown with fresh water.

The increasing use of "fertigation" and humid growing conditions in green houses has enhanced the ability of some crops to effectively use saline water.

Aquifer Recharge

Use of sewage effluent to recharge deep aquifers is practised by the Dan Region of Councils (population 1.3 million people).

Rainfall runoff in the Negev is also used to recharge aquifers by directing all stormwater to Loess infiltration areas.

Mitigation of Salinity Impacts on Infrastructure

Urban salinity and its deleterious impacts are not a major issue in Israel, principally because most aquifers are very deep and there is an absence of dryland salinity. Where elevated, saline groundwaters are evident, mitigation measures employed include:-

- Underdrainage
- Using saline tolerant and low water use native plants in urban landscapes
- Drip irrigation of plants and landscapes
- An absence of shallow rooted lawns and garden beds
- Use of saline resistant/marine grade cement in foundations
- Provision of free draining subgrades and underdrainage to roads and trenches for services
- Lime treatment of subgrades

Control of Blue-Green Algae

The increasing evidence of blooms of blue-green algae in Lake Kinneret and other storages has been of concern to Israeli Water Managers.

Control measures include:-

- Fertiliser use control in catchments
- Use of algicides
- Use of algae eating fish (Tilopia) as a biological control

These measures appear to have been successful in keeping the blue-green algae problem in check.

Future Initiatives

The major water resource management measures expected to be implemented in Israel in the future include:-

- Increasing water conservation efforts in all sectors of use
- Enhanced wastewater treatment, including use of membrane filtration technology
- Increasing use of reclaimed water for agricultural irrigation
- Increasing use of micro-drip, sub-surface irrigation coupled with green house horticulture and enhanced "fertigation"
- Development of saline resistant crops and plants
- Increasing desalinisation of sea water and sewage effluents
- Development of smart genetically engineered bacteria for early toxin detection in all water sources

Other Issues

Other items of interest noted during the Study Tour include:-

- Increasing concerns about boron toxicity in plants (boron is a whitening additive in detergents)
- Concerns about increasing levels of chlorinated hydrocarbons in aquifers (particularly trihalomethane)
- Development of wastewater treatment standards to enable a full range of re-use options (including urban use) for reclaimed water
- Development of alternatives to herbicides and insecticides

- Development of an extensive fish farming industry utilising saline water
- Development of commercial uses for a range of algae
- Increased commercial production of cut flowers using saline water
- Development of terrace farming in the Negev

Summary and Conclusions

This report summarises the findings of a study tour of water resource management in Israel, undertaken by the author in March, 2002.

Although the trip was marred to some extent by security issues and tensions as a result of escalated terrorist bombings throughout the country, the author was not constrained in any way from visiting sites and talking to experts in relevant fields.

Israel is a very small country, with a land area of 25,970 square kilometres and a population of 6.5 million (8.0 million including the Palestinean Territories) which is expected to grow to 9.0 million by 2020.

Most of the country is desert, with only the northern part receiving more than 500 mm rainfall annually.

Water resource management is crucial to the survival and growth of the Country. Renewable freshwater resources have been fully allocated, forcing a review of alternative water sources.

Emphasis is now being placed on the extensive use of reclaimed sewage effluents and desalinisation of sea water. It is anticipated that future supplies of "fresh" water will largely rely on desalinisation of Mediterranean Sea water.

Development of water use efficiency throughout the urban, industrial and (particularly) the agricultural sectors is also considered essential to the on-going prosperity of Israel.

Issues of particular interest and potential relevance to Australia include:-

- The enhanced technology and reduced cost of desalinisation (US$0.527 per kilolitre)
- Increasing reliance on re-use of water reclaimed from sewage effluents. Enhancements to the technology of membrane filtration provide the opportunity for increased use of effluents; even in urban situations
- An emphasis on water conservation and water use efficiency in agricultural irrigation and urban watering. The widespread use of drip irrigation, micro-drip irrigation and sub-surface irrigation results in extremely efficient water use throughout Israel
- Use of saline water (up to 9000 EC, but typically 2500 - 3000 EC) to grow "enhanced" commercial crops of tomatoes, melons, flowers, olives, cotton, alfalfa etc
- Increasing use of green house/hot house agriculture, coupled with drip irrigation and "fertigation" and the increasing use of potassium chloride
- The use of treated sewage effluents to recharge deep aquifers

Other areas of interest to the author include:-

- Biological control of blue-green algae by using fish (particularly Tilopia)
- The absence of urban salinity problems, which are controlled by

extremely efficient water use in landscapes, planting only of water efficient, salt tolerant native species, underdrainage, the absence of lawns and garden "beds" and the extensive use of salt resistant/marine grade cements in foundations and infrastructure

- The increasing concern of boron contamination in recycled sewage effluents and groundwater; originating from whitening additives in detergents

- The increasing use of grey water in urban situations

The study tour was of considerable benefit to the author and to enhancing the understanding of water resource management in a dry land, salt affected, Country. It is hoped that the findings will be of value to local government and particularly to water resource managers throughout Australia.

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- Sharon Davis, MDBC

Appendix A

Appendix B

Figure 2: National Water Carrier

Author Biography

Daryl McGregor graduated from Melbourne University in 1973 with a Degree in Civil Engineering (with honours). He obtained his Master of Engineering Science degree in 1988 from the University of New South Wales, specialising in waste management, and completed his Masters Degree in Business Administration (MBA) in 1992. He is also a qualified Engineer of Water Supply in Victoria, a qualified Municipal Engineer in both Victoria and New South Wales, a Fellow of the Institute of Engineers Australia, a Fellow of the Institute of Public Works Engineering, Australia and a Member of a further eight Professional Associations.

His areas of expertise and interest embrace local government management, water supply, water resources, natural resource management, wastewater treatment and management, civil engineering, traffic management, infrastructure development and environmental management.

Mr McGregor is a Registered Professional Engineer and a Chartered Engineer of the International Council of Engineering Institutions.

He is also an executive of the following professional Committees and Working Groups:-

- Chairperson, Murray Catchment Management Board
- Chairperson, NSW Water Directorate
- Murray Unregulated River Management Committee (Deputy Chair)
- Murray Darling Basin Commission, Community Advisory Committee to the Ministerial Council
- Murray Darling Basin Commission, Community Reference Panel on Environmental Flows
- Murray Darling Basin Commission, Rivers Knowledge Committee

Postal Address: Manager Albury Water, City of Albury, 553 Kiewa Street, Albury NSW 2640 Australia

E-mail: dmcgregor@alburycity.nsw.gov.au