DOMESTIC DIMENSIONS OF THE WATER POLICY OF ISRAEL, (1948-2006)

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DECLARATION

I declare that the dissertation entitled "**DOMESTIC DIMENSIONS OF THE WATER POLICY OF ISRAEL, (1948-2006)**" submitted by me for the award of the degree of **MASTER OF PHILOSOPHY** of Jawaharlal Nehru University is my own work. The dissertation has not been submitted for any other degree of this or any other University.

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CERTIFICATE

We recommend that the dissertation be placed before the examiners for evaluation.

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To

My Beloved

Amma, Akka, Anna, Antu

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Chitra N.

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Abbreviations

BWRO	**Brackish Water Reverse Osmosis**
$CaCO_3$	**Calcium Carbonate**
CO_2	**Carbon-di-oxide**
ED	**Electro dialysis**
GDP	**Gross Domestic Product**
GNP	**Gross National Product**
m^3/d	**Cubic meter per day**
MCM	**Million Cubic Metres**
MED	**Multi Effect Distillation**
Mg/lr	**Milligram per litre**
MSF	**Multistage Flash distillation**
NaCl	**Sodium Chloride**
NIS	**New Israeli Shekel**
NO_2	**Nitrogen-di-oxide**
NWC	**National Water Carrier**
Ppm	**parts per million**
RO	**Reverse Osmosis**
SAT	**Soil Aquifer Treatment**
SO_2	**Sodium-di-oxide**
SWRO	**Sea Water Reverse Osmosis**
TDS	**Total Dissolved Salt**
UF	**Ultra Filtration**
UNEP	**United Nation Environment Programme**
VC	**Vapour Compression distillation**
WDA	**Water Desalination Administration**
WMO	**World Meteorological Organisation**

Chapter 1

Introduction

Long before the establishment of the State of Israel in 1948, the aspiration of the Zionist movement has been to "make the desert bloom." Geographically Israel is located in a semi-arid climatic zone and its natural water sources are severely limited. The total average annual potential of renewable water amounts to 1,800 million cubic metres (MCM), of which about 95 percent is already exploited and used for domestic consumption and irrigation. About 80 percent of the Israel's main freshwater resources are drawn from Lake Kinneret (also known as Sea of Galilee), Coastal Aquifer (along the coastal plain of the Mediterranean Sea), and the Mountain Aquifer (under the central north-south or Carmel mountain range). The amounts of water that can be used from these resources have never been sufficient to meet the demands of growing population.

Water carries a strong ideological connotation for the Israeli desire to make the desert bloom and is related to national interest through agriculture. Conceived as a Jewish national home, Israel is committed to an unrestricted Jewish immigration from the Diaspora. After the Law of Return was passed in 1950, which allowed the Jews in the Diaspora a permanent residence in Israel, waves of immigrants came into the country. The immigration or *aliya* required massive water resources to meet rising demand, but the amount of water available in Israel was insufficient to meet the needs of the new comers. Along with this, since the mid-1960s Israel went through a rapid economic development including industrialization and urbanization, which increased water consumption. In addition to the ideology, demographic change and economic development, water also figured prominently in security-foreign policy calculations of Israel. The failure of several proposals for regional water-sharing arrangements with neighbouring Arab countries, confirms the claim that water is closely linked to foreign policy making of both Arab countries and Israel. Since 1967 water is also linked to the establishment of settlements occupied territories. Water thus has played a crucial role in all aspects of Israel and resulted in the need to formulate its water policy.

In the initial years, the water policy of Israel was ideologically motivated and has passed through many phases. The first phase (1948-1967) was marked by expansion of both water resources and agricultural production. It also established the institutional framework and water policy network. In 1959 Israel enacted Water Law, which vested the ownership of all water resources with the state. It also outlined the structure and functions of the water policy authorities. In this period large scale projects designed to enlarge water resources were financed and implemented and in 1964 the National Water Carrier was completed and this carries water from the north of the country to the centre and south. In early 1960's in collaboration with the US, *Tahal* (water planning agency of Israel) planed a large project for desalination of sea water but was cancelled due to lack of funds.

The second phase (1967-1990) was marked by priority for agriculture expansion over water resources conservation. The capture of West Bank, Gaza Strip and the Golan Heights (as well as the Sinai Peninsula) during the June 1967 war gave Israel control over new sources of water. Since then Israel identified that the problem of water shortage as one of scarcity rather than as a problem of accessibility. The gap between demand and sustainable yields increased with the establishment of new settlements on lands occupied in the 1967 war. Though the dominance of agriculture interest in water policy is recognized, allocation and pricing of water to agriculture are highly scrutinized. In 1988 *Tahal* gave a comprehensive water management Master Plan.

The third phase (post-1990) is marked by the development of non-conventional water resources like large-scale desalination projects to address the problem of water scarcity. Other non-conventional water resources techniques pursued by Israel include cloud seeding and weather modification, sewage reclamation, development of water technologies etc. It attempted to change the composition of the policy network. An official committee recommended the separation of the water and agriculture policies, and also for the privatization of the water sector. In the wake of the Oslo agreements with the Palestinians in the 1990s, water policy ceased to be residual to agriculture policy, because emphasis had been placed on the need to address water related issues. Though the emphasis of its water policy shifted over years, Israel maintained a single master policy, to increase its water resources and to overcome environmental constraints in making the desert bloom.

Review of Literature

The importance of water to the Israelis is basically related to the Zionist ideology of making the desert bloom. Miriam R Lowi (1993) presents this as a psychological perception in realizing the importance of water. Since the Zionist movement encouraged the agricultural activity, it let the Jews return to the land and work in the land and make it productive. Yossi Margoninsky (2006) links the importance of water with the political economy of the agriculture sector. Nadav Morag (2001) places water within the context of geopolitics and state building. The geopolitics of water includes not only external threats to Israeli's existence, but also threats to economic well being of its population and its capacity for future growth through the absorption of the Jewish Diaspora. Because, water issues were important to Israel's geopolitical considerations, Israel desired to control maximum number of possible water resources. The necessity to secure water resources played a crucial role in Israel's geopolitical calculations with respect to Syria.

Water is also important in state building (Nadav Morag, 2001). Since 1948 absorption of a large number of immigrants to strengthen Israel's demography became vital. Water was also needed to develop Israel's agriculture sector, which ideologically and economically of crucial importance in the pre-state and early state period. Thus the importance of water to Israel's is felt in different aspects. But the availability of water is less, which may be sufficient to meet the present demand but it would not fulfil the future demands. Thus need arouse to increase the water resources, to conserve it and manage it for future needs. This can be achieved by policy network, so came the water policy.

Gila Menahem (2001), discussed about the policy paradigms, policy network of water policy in Israel. She discussed about three water policy paradigms, where initial one was of expanding water resources and agricultural production; then the priority agriculture expansion over water conservation; and the last of water management for future demands. The water policy of Israel is fought with uncertainties. David Dery and Ilan Salomon (1997) associated the water policy with uncertainties like high vulnerability of water system, inclination of elected policy makers to give preference to short-term objectives over-long term objectives and the acceptance of a given level of agricultural activity as a permanent constraint.

Another dimension of policy is the political economy of water policy. Shlomo Mizrahi (2004) argues that the power of a sectoral interest group and its influence on public policy can be evaluated according to the level of centralization of the political, economic and bureaucratic systems, as well as the level and type of political participation at the social level. He strongly argued about the power of agriculture lobby in making water policy, especially with regard to water allocation, pricing etc. For, Uri Davis, Antonia E L Maks and John Richardson (1980) water policy evolved only after June 1967 Arab-Israeli war. They had viewed the policy in futuristic way and analyzed the water policy of the past decades and suggested Dead Sea Mediterranean Canal, and other techniques for non-conventional water resources.

Though the water policy of Israel is found initially in expansion of water resource and agriculture production, it did not realize the power of agriculture sector in the policy making. For historical, ideological and institutional reasons, agriculture has been regarded as a key national interest issue in Israel (Shlomo Mizrahi, 2004). Agriculture sector also had strong ties to the Labour party which dominated Israeli politics during 1948-1977. Mizrahi (2004) had examined the strong relation between the agriculture sector and the water policy. Though in the 1990's the agriculture lost its central role in the economy, it still plays a major role in the water policy making. Yossy Margoninsky (2006) examined the political economy of rent seeking by the agriculture sector in water pricing. He had examined the power of Israeli farmers in retaining their political dominance, even when their sector was shrinking. The farmers are effective in rent seeking against the Ministry of Finance to buy water at subsidized rates. Thus agriculture plays a major role in the water policy making even though its sector is shrinking.

If one looks into structure and function of water policy making authority, it involves the Ministry of Agriculture, Water commissioner, Water council and a Knesset (parliament) subcommittee for water. According to Menahem (2001), they comprise the water policy network. The issue of water is also dealt by different ministries including the Ministries of Finance and Infrastructure. Since this water policy is dealt by many ministries, there is a considerable overlap and clash in formulation and implementing policies. This leads to ineffective implementation of water policy. Shlomo Mizrahi (2004) had highlighted the conflict between the Ministry of Agriculture and Ministry of Finance regarding pricing and allocation of water to different sectors.

In order to find a solution to the problem of water shortages, non-conventional techniques of water production is used. Arnon Soffer (1999) had given many solutions starting from importing water through pipelines, desalination, trapping flood water, cloud seeding, etc. But how far these techniques are going to meet the growing demand of water has to be studied.

Scope of the study

The water policy in Israel is more or less an agriculture policy. This study looked in to the influence of agriculture sector in making of water policy with respect to quantity of water allocation, pricing of water through subsidy etc, though its share in the GDP is low. This study also analysed the lacunae in the institutional framework of water policy and policy networks in bringing about effective implementation of water policy. The other area ventured in to, is alternative source of water through non- conventional resources like desalination of seawater, desalination of brackish water, effluent treatment, cloud seeding, import of water from other countries, etc. This study also examined the effectiveness of technologies to meet the ever increasing water demand in the country. The study however does not seek to examine Israel's water policy regarding the occupied territories or the role of water in its peace policies towards the Palestinians and other Arab countries. These issues need to be treated exclusively and extensively. Hence, the research is confined to water policies within the June 1967 boundaries.

Research questions

1. Why is the agriculture sector so influential in the making of Israel's water policy?
2. What are the institutional failures in bringing about effective implementation of water policy?
3. How far the technologies used for production of non-conventional water resource are feasible and cost effective?

Hypothesis

- Israel's water policy is directed towards the interest of the agriculture sector.
- Israel would have to rely on non-conventional alternatives to meet its increasing demand for water.

Research methods

This study was analytical as well as descriptive. The development of water policy is analysed in different phases. The policy shift in different phase was studied with relevant background. The increasing demand of water from various sectors and the dominant role played by agriculture sector in water allocation, pricing, etc are analysed. The institutional framework of Israel in making water policy is examined towards the formulation of water policy including its implementation, water allocation, subsidy, pricing, quota, quality and pollution control. Data collected from both primary sources and secondary sources. The official hydrological data of the State of Israel, especially of *Mekorot* (National Water Company), Central Bureau of Statistics, Water Commission Report and report of the Parliamentary Committee of Inquiry on the Israeli Water Sector, are extensively used to examine role and importance of agriculture and the political interests of various parties and interest groups.

The second chapter on *Water Policy and the Role of Agriculture Sector* examines the agriculture sector in Israel and its role in the water policy making. The Zionist ideology with the historical background which stood for the dominance of agriculture sector in the water policy is discussed in details. The foundation of agricultural settlements including *Kibbutzim* and *Moshavim* [1]as the nucleus of the new Jewish state is discussed with the political factors. The contribution and *Kibbutz* and *Moshav* in the GDP and their present situation is analysed by taking in to account the employment status, agriculture production, water consumption, etc. The antecedents of agriculture with the initial purchase of land during the beginning of 19^{th} century and its gradual spread is discussed The agriculture land use is analysed by looking in to the shrinking land area under agriculture and the main reasons for this. The shrinking labour market in the agriculture

[1] *Kibbutzim* is the plural of *Kibbutz* in Hebrew and *Moshavim* is the plural of *Moshav* in Hebrew.

sector because of various reasons like declining agricultural land area and its share to the GDP, inclusion of foreign workforce, industrialisation, mechanisation of agricultural operations which limits the manpower, declining kibbutz involvement in agriculture etc are examined.

Since agriculture sector consumes more water than the other sectors, hence comparative analysis becomes essential. The major trend in consumption pattern during the years and the cause of it is also discussed in detail. The importance of agriculture in the economy is accounted by the quantity of agricultural product export. The change in the export product clearly reveals that agriculture sector is losing its importance in the national economy. On the whole this chapter deals with the different aspects of agriculture in Israel and their present status regarding water and contribution to labour market and GDP.

The third on *Institutional framework of water policy: Role and Failures* examines different agencies and ministries that deals with water policy in Israel. Water is regarded and treated differently by different authorities and major stakeholders. The implication of the Water Law 1959 and the authority given to different Ministries are discussed. There is no clear division of power and there is major tussle between different ministries. The deep connection between agriculture policy and agriculture lobby which succeeds in getting more allocation of water and demanding subsidy for water prices were discussed in this chapter. The legislative framework of water is discussed in relation to the water law 1959 and the other existing laws related to water. The organisational framework of ministries and other actors in water sector, their power, role and authority are also examined. The major concern of this chapter is analysing the tussle between these ministries and other agencies regarding the power, area of operation, hierarchical position, political support, and authority. This was done with support of the Parliamentary Committee of Inquiry on the Israeli Water Sector (2002) and the Water Law (1959). The major components of water policy discussed here includes its formulation and implementation, supply and distribution of water to different sectors, water quota, subsidy and water price, water quality, preservation of natural sources, prevention of pollution, budget and expenditure, security and foreign affairs, co-ordination among different ministries, advisory, planning and making master plans etc.

Besides the conflict of interests of different ministries, this chapter deals with the legal and organisational framework of water policy in Israel and the major problems encountered for managing the scarce resource water in Israel.

The fourth deals with the alternative water resources that Israel sough to exploit since 1990s. This chapter examines the policy shift towards alternative water sources because of the decreasing supply of water to the increasing consumption. The demand and supply of water by the different sectors in Israel is discussed with the major sources of supply. While talking about the need for alternative water resources, this chapter takes in to account the major problems faced by the sources such as Lake Kinneret, Coastal aquifer and the Mountain aquifer due to over exploitation, salination , chlorination and pollution. The reasons for the depletion in quality of water and less availability are examined through increase in population and pace of urbanisation. Regarding alternatives the chapter examines desalination of sea water, desalination of brackish water, recycling of sewage water, importing water from other foreign countries and cloud seeding. The main desalination techniques are discussed in this chapter along with the cost as well as environment considerations.

The final chapter summarises the findings of this research and answers the research questions and hypotheses outlined at the beginning.

The major drawback of this study is non availability of data for consecutive years.

Chapter 2

Water Policy and the Role of Agriculture Sector

The Jewish people were originally farmers. From an ideological and historical point of view, the Zionist ideology regarding agriculture needs to be mentioned. After the World War I came to an end, the Zionist movement, which had been formed in the closing stages of the 19^{th} century, actively pursued a homeland in Palestine. Access to fresh water resources was a guiding principle in determining where the borders of a viable Jewish state were to be. Hence it was suggested that the Jewish homeland not only include all of the Jordan River[1] but also the Litani River in present-day Lebanon (Mahmoud, 1985:10). Fundamental to this water-oriented political agenda, which linked state territory to water resource availability, was the socialist-Zionist idea of a "new Jewish human being" (*Chalutziut*) whose purpose was to cultivate the soil and thereby contribute to the constitution of a new social order based on agricultural collective settlement (*kibbutz*).[2]

During the Mandate period (1921-48), the Jewish Agency for Palestine which was actively involved in purchasing lands, founding agricultural settlements and building an agricultural based economy in Palestine publicized this idea widely. The immigration of agriculture-oriented Zionists to Palestine in the early 1920s, construction of quasi state administrative structures (the Jewish self-administration during the British Mandate era) and foundation of ever more agricultural settlements (*Kibbutzim*) as the nucleus of the new Jewish state, were constant political factors even before the proclamation of Israel in 1948 and are continuing to shape it even today.

The first *kibbutz* was founded on 1908. By the end of 1948 there were 54,200 people (six percent of the population) living on 177 *kibbutzim*. At the end of 1998 there were 267

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[1] This includes its three tributaries, Dan, Hasbani, and Banias.

[2] There are three distinct types of co-operative agricultural settlements in Israel. *Kibbutzim* (Collective Community) which is mainly an agricultural co-operative community. Land, factories, buildings and equipment are owned jointly (collectively) by the community. *Moshav* (Farming Village) A more or less self-contained farming village. Each farm is held and farmed independently by the settler and his family. Moshav Shittufi (Collective Settlement) combines the co-operative ownership and working of land and factories (as in a *kibbutz*) with maintaining the strength and independence of the family (as in a *moshav*).

kibbutzim with 115,500 inhabitants which accounted for two percent of the population. The population of the *kibbutzim* increased until the late 1980s, since then it has been decreasing. The immigrants of 1990-1991 who settled on *kibbutzim* halted this trend temporarily. During 1992-1998 the population of the *kibbutzim* decreased by approximately 14,000 persons (11 percent). During this period the Jewish population of Israel increased by 15 percent (total population by 19 percent) (Tabenkin, 2000:3).

The net domestic product from *kibbutz* agriculture increased over the years, as with Israeli agriculture in general. However, its proportion of the total product decreased, in view of the relatively greater increase in other product components (particularly the industrial product), and the decline in the relative price of agricultural products. The share of the *kibbutzim* in the gross value addition to agriculture has decreased since the early eighties due to the decrease in field crops, primarily cotton. Aside from *kibbutzim*, *moshavim* and collective *moshavim* or *Moshav Shittifi* account for 38 percent of agricultural land, nine percent land lays in private ownership and other entities in the Jewish sector, and the Arab sector accounts for 15 percent. Following the decrease in the profitability of agriculture, the number of *kibbutz* members working in this sector decreased. This was accompanied by an increase in the number of employees. Fifty-four percent of the value of the *kibbutz* agricultural output comes from livestock and the remaining 46 percent from crops. Over the years, the field crops branch in the *kibbutzim* has decreased primarily due to the decrease in cotton growing, even though it has remained the largest branch; the proportion of the vegetable, potatoes and melons branch has increased. The flowers branch has grown rapidly, even though it is still only a small part of all crops.[3]

The agricultural cultivation of the Negev desert (following David Ben-Gurion's call to "make the desert bloom") carried with it some strategic considerations. On the one hand, Jewish communities in rural and previously uncultivated areas were supposed to impede future Arab re-conquest of these areas. The agrarian work and activity among the new Jewish immigrants, who came predominantly from Eastern Europe, were supposed to create patriotic feelings for the agrarian work and to secure their allegiance to the new

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[3] For details refer Yad Tabenkin, Central Bureau of Statistics, January 2000, Statistical 6, ,http://www1.cbs.gov.il/www/statistical/qibu-eng.pdf, accessed on 2 March 2008.

state. The major idea behind this was that a person who had cultivated his land with hard labour would be less likely to abandon it. On the other hand, the cultivation of rural areas was also aimed at promoting a certain level of autarchy in the field of food and nutrition.

Apart from these ideological underpinnings, the state also witnessed the formation of bureaucratic structures in the agricultural sector. The establishment of a centrally organised water supply system served strategic interests and once again underlined the central importance of agriculture in the political system. For long the Water Commission, which is responsible for water distribution and management, had been under the control of the Ministry of Agriculture and was only placed under the responsibility of the Ministry of Infrastructure in 1996. Subordinate to this national water agency are two organizations namely *Tahal* which is charged with planning and exploration tasks while *Mekorot* that oversees the construction and maintenance of all national water supply installations (MERIP Reports, 1982:19-24).[4] Both *Tahal* and *Mekorot* support Zionist-agrarian interests due to their ideological orientation. The relatively low water tariffs in agriculture, compared to the high tariffs in industrial sector and private households and the high level of direct subsidies for the agricultural sector thus become more plausible because of this background.

Agriculture still remains a central component of the national identity. The continuing importance attributed to agriculture is primarily linked to cognitive difficulties that stand in the way of reforming ideological symbols about agriculture. More specifically, there was a widely held belief that the transformation of uncultivated lands into agricultural lands could be seen as an index of the country's success, while the opposite, that is, the cessation of this activity could be interpreted as failure.

Another importance of agriculture to the national identity has been the perception about the on-going conflict with the Palestinians. Both sides in the conflict continue to cling to elements of national power, such as territory and natural resources. In Israel this becomes manifest not only in the emphasis on the close bond between the people and the land, but also with regard to demonstrating territorial sovereignty and effective control over the

[4] *Tahal* and *Mekorot* are semiprivate organisations whose major stockholders are the Jewish Agency and the Jewish National Fund. The *Mekorot* Water company was established in 1937 and *Tahal* in 1952

territory. This political objective can be clearly observed in the establishment of a number of villages along the 1949 Armistice lines (Kartin, 2001:278). As Prime Minister Moshe Sharette once observed, "Water for us is life itself. It is food for the people and not food alone. Without large-scale irrigation — we shall not be a people rooted in the land, secure in its existence and stable in its character."[5]

Apart from these difficulties that stand in the way of reforming ideological symbols about agriculture, there are restrictive institutional and administrative arrangements. Furthermore, there exist strong agricultural interest groups such as *Kibbutzim* and the Jewish agricultural associations which have considerable influence upon agricultural policies, which no Israeli government could ignore. Despite limited changes in Israel's agricultural policy between 1986 and 1993[6] and again in 2000 towards more economic approach water prices and an overall reduction in the amount of water or quota available to the agricultural sector, the Israeli government reversed these measures again after 1993 to improve Israel's bargaining position in the peace negotiations, and endorsed them in 2002. In view of the ideological reasons and because of the involvement and influence of powerful interests, the agricultural sector continue to maintain its privileged position in Israel's political and social sphere (Kartin, 2001:273-282).Out of the total area available, agriculture occupies around one quarter of land (**Table.2.2**) and is predominant when compared to the other sectors. Though both the land under cultivation and its contribution to the GDP are decreasing, agriculture sector holds a stronger position in the politics of Israel and especially, in the water policy making.

2.1.Role of Agriculture in Water Policy Making in Israel

Water policy in Israel is deeply intertwined with agricultural policy. Since agriculture has historically played a role in the nation building process within Zionist ideology, it held a symbolic importance in the movement to rebuild the social structure of a people who gathered from the Diaspora and to inhabit the territory and ultimately to achieve statehood. Recent decades have witnessed a decline of the dominant ideology in Israel, and the reduced role of agriculture in the face of industrialization and post-

[5] Quoted in Feitelson and Haddad 1994, p. 73

[6] There was severe drought and water availability to agriculture sector was limited.

industrialization processes. But water policy in Israel continued to be addressed within the framework of agricultural policy (Menahem, 2001:23). Israel's water policy is also directed by the water economy of Israel which in is directed by its policy regarding agriculture, industrialization and urbanization.

The distribution of water for agriculture is divided in to three main phases. The first phase began in the first decade of the state and agricultural planning focused on three main objectives which include absorption of Jewish immigration, agricultural settlement[7] and food production. The second phase (1958-1968) emphasized on development of export-oriented agriculture including citrus, avocado, flowers and new industrial crops such as cotton. The third phase during 1968-1978 was directed towards improvement of production and agricultural technology. Development during this decade shaped the profile of Israeli agriculture where nine percent of the population were employed in farming activity but produced 75 percent of the food consumption for over three million citizens of Israel. During this period over one third of the total annual agricultural production was exported, with income from exports covering approximately the cost of food and agricultural machinery imports (Uri Davis, 1985:18). Thus, it is very clear that the water policy has primarily advanced agricultural interests. Water resources management was seen essential for ensuring the expansion of agriculture and thus water policy and agricultural policy became intertwined. In fact many policy network members concurrently represented agricultural and water interests, including the Minister of agriculture and the Water Commissioner and traditionally both occupants were personally affiliated with the agricultural sector.

Water policy making in Israel involves the Ministry of Agriculture, Water Commissioner, Water Council and a Knesset Committee for water. Until recently the supreme authority for the formulation and implementation of water policy rested with the Minister of Agriculture. The Water Commissioner, who heads the Water Commission, is also appointed by the Minister of Agriculture. The Water Committee was a parliamentary sub-committee comprising members from economy and finance committee who are mostly affiliated with the agriculture sector. In the Water Council, out of 39 members 21 are

[7] Some 400 new settlements were established in this decade. But the expression settlement should not be confused with the Jewish settlements that Israel established in the occupied territories since 1967.

representatives of water consumers, of whom the majority are affiliated with the agriculture sector. The 'Agricultural Centre', a body which represents the large majority of Israeli farmers and organizations is always guaranteed a representation of 13 members on the council (Menahem, 2001:28). Thus it may is clear that the agricultural interests in the policy network have representation in the Knesset, Ministry of Agriculture and the administration through the political appointment of the Water Commissioner

2.2. Antecedents of Israeli Agriculture

At the end of the 19^{th} century, Jews began to think about national renaissance in Palestine through a "Zionist movement." The simple impulse was to reclaim the Jewish national birthright as an indigenous people in their promised land. Farming was a critical part of the vision. Aaron David Gordon was not just an influential Zionist philosopher whose writing articulated this impulse, he also personified it. After working as a book keeper in Russia, he moved to Palestine in 1902 at age 47 and redefined himself as a farmer at the first Zionist *kibbutz* Delanie, on the banks of the Sea of Galilee: He perceived agricultural labour as not only restoring an abandoned land, but also to a damaged Jewish spirit. In his 1920 essay, *The Task Ahead* he wrote:

> We Jews have developed an attitude of looking down on physical labour.... But labour is the only force which binds man to the soil... it is the basic energy for the creation of national culture. This is what we do not have, but we are not aware of missing it... In my dream I come to the land. And it is barren and desolate and given over to strangers; destruction darkens its face and foreigners rule in corruption. And the land of my forefathers is distant and foreign to me and I too am distant and foreign to it. And the only link that ties my soul to her the only reminder that I am her son and she is my mother is that my soul is as desolate as hers (Tal, 2002:3).

The "back-to-the-earth" ethos adopted by the Zionists can be easily understood but what is less comprehensible and more impressive in retrospect was the phenomenal success of this comparatively small cohort of Jewish agricultural pioneers who actually implemented this philosophical formula. With practically no training, they moved half way around the world, became farmers and lived up to their own axiom of "conquered the wilderness"

Yet, the Jewish agricultural effort confounded many non-Zionists Jewish sceptics and proved the potential fecundity of the land of Israel. The Zionist movement was adept at fund raising and much of the funds raised were earmarked for agriculture. Though the real estate that Arab landlords were willing to sell was largely malaria infested swamps and wastelands, new agricultural settlements soon began to dot Palestine. British land decrees limiting Jewish ownership slowed progress dramatically, but this 1940 table from the *Palestine Statistical Abstract* indicates the steady, almost geometric, increase in Jewish agricultural activity. The increase in agricultural land area was six fold in just 30 years of time **(Table.2.1).**

Table.2.1.Jewish Settlements and Land Area

Year	Number of Jewish Settlements	Inhabitants	Land Area
1899	22	5,000	300,000
1914	44	12,000	400,000
1930	107	45,000	1,050,000
1936	203	98,300	1,480,000
1939	252	137,000	1,650,000

Source: Tal, Alon, "*To Make a Desert Bloom: Seeking Sustainability for the Israeli Agricultural Adventure*" The Blaustein Institute for Desert Studies, Ben-Gurion University, 2002,pp.5

While the Jewish farms supported livestock and a variety of vegetables and fruits, the crop choice for most settlers was citrus. Between 1918 and 1938, Jews invested 70 million dollars in orange groves, and production grew seven-fold. Orange groves generated 80 percent of Palestine's export revenuess and were the single largest income generator, even though they only filled four percent of Palestine's eight million hectares of agriculture lands. The success was ostensibly due to another conscious choice by the Zionist farmers: they eschewed the existing agricultural methods and technologies of the local Palestinian peasant population – the *fellahin*. Theirs was to be a modern, Western agriculture. This dismissive attitude towards indigenous Arab population can be seen even in the brief quote by Aaron David Gordon, who in fairness, was among the conciliatory Zionist leaders towards the Palestinian Arabs. The Zionist adage *"A land without a people for a people without land"* did not so much suggest that the Arab population was invisible, but that their national claims and culture were less worthy. Years later, Israel's founding first Prime Minister, David Ben-Gurion, a genius at languages who spoke at least eight, refused to learn Arabic on the premise that Israel could only succeed as a European nation and that learning from the locals would be a strategic mistake (Tal, 2006:5).

Once Israel was established in 1948 and the Zionist settlement agencies were freed of the constraints of British land and water proscriptions, the new Jewish State set out on a drive to expand agricultural production. In five years, during the 1950s, cultivated lands increased by 150 percent with the percentage increase of irrigated plots even higher **(Table.2.2 and 2.3).** The National Planning and Building Law was altered so that the default zoning opened spaces for "agricultural usage." Changing the classification of farmlands required approval of a committee dominated by agricultural interests.[8] During this period, agricultural settlement actually doubled, with the number of Jewish farming communities increasing from 300 to 600. Areas that had been written off for millennia as desert re-emerged as arable lands, as the ideological fervour that characterized the pioneer spirit was given a state-supported framework that both deified and subsidized agriculture (Tal, 2002:8).

The steady growth in yields has managed to continue to the present, even as the trends in new land development levelled off. As **Table 2.2** indicates during 2001 roughly a quarter of land in Israel is being utilized for agriculture production and this rate is fairly steady. This proportion is extremely high considering that most of the country is arid or semi-arid in its precipitation levels.

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[8] For details also refer to Feitelson, Eran, (1995), "Protection of Open Spaces in Israel at a Turning Point," *Horizons in Geography*, 42-43, pp.9-13.

Table 2:2 Land Use in Israel

	Thousands of Hectares	Percent of total lands
Total Area of Israel	2,245,000	100
Built Areas	200,000	8.90
Non-Agricultural Open	1,146,000	51.0
Nature Reserves and Forests	347,000	15.5
Pasture	141,000	6.30
Arable Lands	411,000	18.3

Source: Tal, Alon, "*To Make a Desert Bloom: Seeking Sustainability for the Israeli Agricultural Adventure*" The Blaustein Institute for Desert Studies, Ben-Gurion University, 2002,pp.9

As to the composition of Israeli agriculture, **Table2.3** provides a general breakdown of production according to land use. Given the climatic conditions the majority of agricultural lands are irrigated. Roughly a quarter of agricultural lands are dedicated to orchards, with citrus still comprising a major component of local fruits, even as the groves have migrated south to the northern Negev. Flowers and ornamental plants, intensely raised in greenhouses, provide revenues far greater than their 1.6 percent of land space. In general some 1456 hectares of land are utilized as green or "hot" houses. **(Figure.2.1)**

Table 2.3: Agricultural Use of Land in Israel

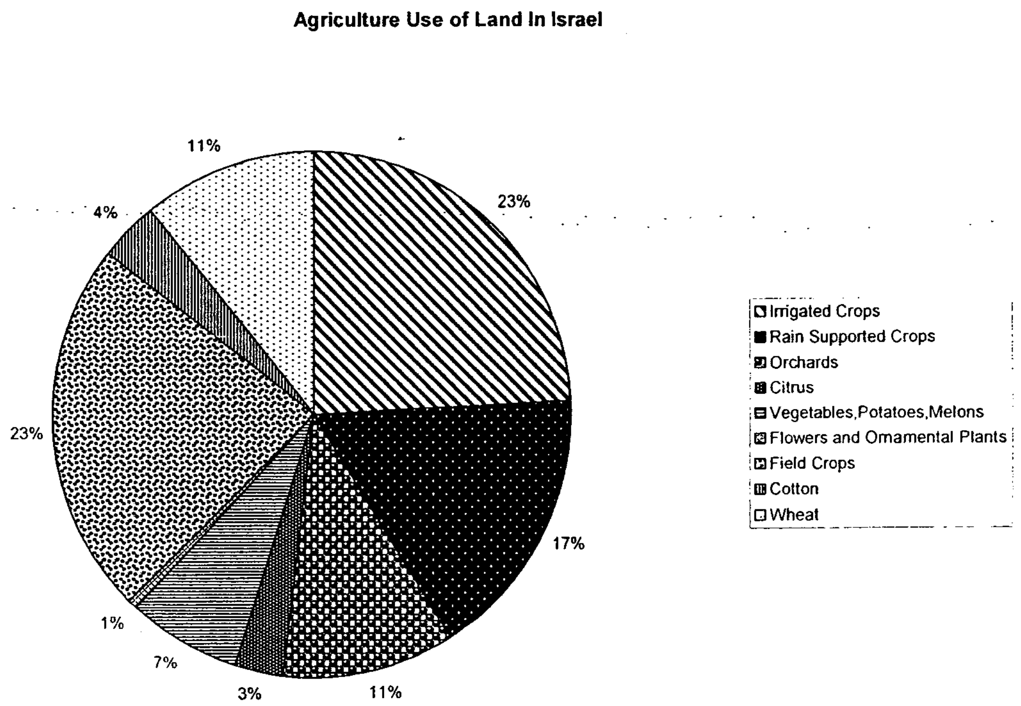
	Thousands of Hectares	Percent of total lands
Total	382.2	100
Irrigated Crops	192.3	58.6
Rain Supported Crops	136.9	41.4
Orchards	84.80	25.8
Citrus	25.30	7.70
Vegetables, Potatoes, Melons	55.10	16.8

Flowers and Ornamental Plants	5.20	1.60
Field Crops	183.00	55.8
Cotton	29.00	8.80
Wheat	86.00	26.2

Source: Tal, Alon, "*To Make a Desert Bloom: Seeking Sustainability for the Israeli Agricultural Adventure*" The Blaustein Institute for Desert Studies, Ben-Gurion University, 2002, pp.10

The irrigated crops constitute 58 percent of the total lands, which mean the water requirement is high. In comparison the rain supported crops occupies only 41 percent where mostly crops are cotton and cereals.

Figure.2.1. Agriculture Land Use 2001



Source: Adopted from **Table.2.3**

It is worth mentioning the agricultural fate of the 150,000 Arabs who remained in Israel after the 1948 war. Most Palestinian Arabs fled the country during the fighting for a variety of reasons and the new state was not interested in rebuilding the Fellahin communities who remained hostile and sought to re-establish Arab control over state lands. In many cases, Arab farmers were not allowed to return to their homes. Under the 1950 Absentee Property Act they were paid compensation that fell far short of the land's actual value. About forty percent of private-Arab land resources were confiscated during this period and hence Arabs, who currently account for 20 percent of the population, own only 3.4 percent of the lands. This shift in land ownership was certainly not an objective of the young State as it set about defending itself from the attacks of five Arab armies and the local Palestinian Arab militias, but it was an undeniable outcome. With the loss of most of their lands, the already beleaguered "fellah" economy went into free fall and could not compete with the highly mechanized Jewish agricultural sector. By the 1990s, only 8 percent of Arab-Israelis made a living in agriculture (Tal, 2002: 10).

Even where they held onto their plots, the Arabs found it difficult to stay in farming. The state severely limited their water and electricity quotas, particularly when compared to the more productive neighbouring Jewish communal and cooperative farms. The Arabs found themselves excluded from the country's powerful marketing, credit and purchasing cooperatives. Arab-owned citrus groves all but disappeared, in the 1950s the fellahin fell back on subsistence production with supplemental marketing of olive oil. It is thus not surprising that many Israeli Arabs abandoned agriculture altogether. The land became the domain of those with the machinery to exploit. By the 1960s and 1970s, Arab agriculture in Israel underwent significant mechanization and cash cropping with the Israeli research organizations speaking of a shift from fellah to farmer (Tal, 2002:11)

Yet many of the very factors that created such agricultural prosperity have changed often not for the better. Indeed, there is a wide perception among Israelis that agriculture in has lost its lustre, comparative advantage and most importantly, its future (Hillel, 1982:39). While agriculture provided 30 percent of national GNP during the 1950s, in 2000 with 3.2 billion dollars in annual production it accounted for only 1.6 percent of GDP. The trends raise serious questions about the sustainability of Israel's present agricultural economy (Tal, 2002:12).

2.3. The Shrinking Agricultural Land Area

The agricultural land under irrigated crops was only 300 dunams[9] during the establishment of the state. This was because there was not major water conveyance to carry water from the place of origin to where it is required. Initially agriculture was also practiced only in less area because of settlement activities which was in full pace. Irrigating crops in a semi-arid environment needs technological advancement and introduction of crop variety which requires less water and gives good yield. After the construction of National Water Carrier in 1964 there was major boon to the agriculture sector by transferring water from the Lake Kinneret in the north till the Negev Desert in the south. This led to the major increase in land area under irrigated crops and increased from 1500 dunams in 1964 to 2000 dunams in 2000. Subsequently, because of increase in immigration, urbanization and failure of monsoon gradually led to a decrease in the irrigated crops. During the year 2000 the area under irrigated crops reduced to 1800 dunams which was 20 percent decrease in ten years **(Table.2.4).**

Table.2.4 Cropped Area and Irrigated Area (In Thousand Dunams)

Year	Crops Area During the Year (Thousand		
	Vegetable	Field	Irrigated
1948/49	70	955	300
1949/50	131	1,720	375
1958/59	282	2,710	1,240
1959/60	264	2,451	1,305
1960/61	267	2,754	1,360
1961/62	287	2.448	1,426
1962/63	304	2,422	1,472
1963/64	303	2,664	1,462
1964/65	301	2.633	1,510
1965/66	308	2,439	1,542
1966/67	307	2,629	1,588

[9]Dunam is a unit of area used in the Ottoman Empire and still used, in various standardized versions.In Israel One Dunam is equal to 1000 square metres.

1967/68	321	2,605	1,616
1968/69	342	2,611	1,662
1969/70	346	2,518	1,720
1970/71	370	2,524	1,720
1971/72	396	2,566	1,765
1972/73	354	2,504	1,760
1973/74	376	2,701	1,755
1974/75	368	2,695	1,800
1975/76	339	2,595	1,835
1976/77	367	2,662	2,034
1977/78	402	2,549	1,998
1978/79	357	2,536	2,069
1979/80	355	2,593	2,003
1980/81	335	2,530	2,033
1981/82	340	2,420	2,238
1982/83	351	2,497	2,194
1983/84	364	2,303	2,268
1984/85	390	2,417	2,327
1985/86	391	2,381	2,193
1986	391	2,381	2,193
1987	406	2,340	2,072
1988	403	2,320	2,135
1989	430	2,360	2,181
1990	461	2,196	2,057
1991	504	2,137	1.814
1992	516	2,201	1,871
1993	542	2,178	1,919
1994	552	2,141	1,957
1995	558	2,184	1,943

1996	497	2,139	1,924
1997	516	2,148	1,943
1998	538	2,180	1,985
1999	555	1,824	1,921
2000	551	1,849	1,866

Source: Land and Crop Area, Agricultural Area Basic Data, Statistical Abstracts of Israel, 2001, Table.19.1, pp.1, http://www1.cbs.gov.il/reader/, accessed on 7 febraury 2008.

In terms of types of crops, field crops[10] occupy the major portion of agricultural land. With the establishment of settlements and flowing immigrant population, there was need for additional food crops. With the initial ideological tie ups, Israel continued to grow field crops to meet its domestic demands. Within a decade of establishment of state the area under field crops and vegetables reached to 2800 dunams from only 900 dunams in 1948. From then on there was a gradual increase in the area under field crops and it reached its peak during 1973-75, where it crossed 2900 dunams out of 4000 dunams of total agricultural area. But over the years the land under field crops started declining because of cuts in water quotas and lesser supply of fresh water. Farmers started to switch over to vegetables and plantation crops which are grown in green houses and through modern irrigation technologies which require less quantity of water. So the area under them also changed. The area under field crops started declining from 2500 dunams during 1970's to 1980's to 2196 dunams in 1990's.This was mainly due to water cut quotas and the pricing structure introduced in the water policy. During 2000 the area under field crops was only 1849 dunams while areas under vegetables, plantation crops and flowers and garden plants started increasing gradually because of the advancement in technologies and the export oriented profitability. This clearly shows the tendency of farmers change in utilizing the land for other plantation and vegetable crops instead of field crops. **(Table.2.4 and 2.5)**

[10] Field crops mainly include cereals, pulses, oilseeds, etc. which are grown according to the soil type and climatic conditions.

Table.2.5 Agricultural Area by Activity (Thousand Dunams)

Year	Agriculture Area by Activity (Thousand Dunams)						
	Vegetables and Field Crops	Flowers and Garden Plants	Fishery	Citrus	Other Plantation Crops	Other Uses	Total
1948/49	986	-	15	125	230	244	1,600
1949/50	1,804	-	22	132	245	197	2,400
1958/59	2,838	-	46	300	385	331	3,900
1959/60	2,562	-	49	328	394	567	3,900
1960/61	2,862	-	53	340	413	232	3,900
1961/62	2,592	-	56	370	417	465	3,900
1962/63	2,577	-	58	385	422	458	3,900
1963/64	2,843	-	59	402	429	267	4,000
1964/65	2,809	1.0	61	410	425	294	4,000
1965/66	2,623	1.5	60	416	426	473	4,000
1966/67	2,880	2.0	59	418	431	260	4,050
1967/68	2,813	2.5	57	418	434	325	4,050
1968/69	2,808	3.0	55	420	433	331	4,050
1969/70	2,733	4.0	54	420	420	419	4,050
1970/71	2,731	4.7	56	420	415	423	4,050
1971/72	2,787	5.0	56	426	419	357	4,050
1972/73	2,692	6.0	56	421	425	450	4,050
1973/74	2,915	7.0	56	420	430	272	4,100
1974/75	2,903	8.0	51	425	436	327	4,150
1975/76	2,728	9.1	51	430	392	590	4,200
1976/77	2,818	12.2	49	420	435	516	4,250
1977/78	2,749	17.3	44	408	447	635	4,300
1978/79	2,703	19.4	41	410	471	756	4,400
1979/80	2,677	17.3	39	412	464	791	4,400
1980/81	2,684	14.7	38	411	494	658	4,300
1981/82	2,538	14.7	40	400	540	767	4,300
1982/83	2,683	14.3	38	370	551	644	4,300
1983/84	2,469	14.1	33	375	529	880	4,300
1984/85	2,640	15.7	28	366	533	717	4,300
1985/86	2,523	17.4	25	364	535	836	4,300
1986	2,523	17.4	25	364	535	836	4,300
1987	2,552	19.0	25	359	535	810	4,300
1988	2,571	20.0	25	354	535	795	4,300
1989	2,652	20.8	28	355	534	710	4,300

1990	2,581	21.3	29	342	533	844	4,350
1991	2,577	27.8	28	334	527	856	4,350
1992	2,632	30.6	29	326	523	809	4,350
1993	2,599	33.1	31	322	526	839	4,350
1994	2,575	36.1	31	305	535	868	4,350
1995	2,621	39.2	32	277	546	785	4,300
1996	2,516	43.0	33	277	553	796	4,218
1997	2,547	45.6	32	267	559	795	4,246
1998	2,595	49.1	33	260	577	706	4,220
1999	2,454	52.4	33	253	595	820	4,202
2000	2,480	53.4	33	235	623	812	4,236

Source: Land and Crop Area, Agricultural Area Basic Data, Statistical Abstracts of Israel, 2001, Table.19.1, pp.1, http://www1.cbs.gov.il/reader/, accesed on 7 February 2008.

2.4. The Shrinking Labour Market

Israel's population has grown geometrically due to massive immigration and to a lesser extent, a relatively high birth-rate. At the end of the 1948 war, there were hardly a million citizens. In 2008 the population stands around 7 million. This clearly created an employment challenge. During the 1950s, agriculture provided jobs for hundreds of thousands of immigrants as well as indirect employment in related services. Agricultural jobs paid reasonably well and were part of the pioneering fervour that accompanied the creation of the Jewish State. But the appeal began to wane by the late-1970s and 1980s. Several reasons were responsible for this. Technology and mechanization supplanted many labour intensive practices. As the society became more affluent, agricultural wages for labourers began to dwindle and became unattractive.

Keeping up the agronomy meant massive investment in technology, infrastructure and machines. Agricultural operations, whose justification had initially been largely ideological or political, found that they could not make ends meet (Schwartz, 1995:16) Small farms began to opt out and agriculture, as a livelihood was perceived as less prestigious and was less lucrative than other professions. The number of family farms dramatically decreased with scores of small operations defaulting on loans during the triple-digit inflation of the 1980s "inflated" to extraordinary levels, and most sought alternative employment (Kislev, 1993:272).

Official records show that between 1981 and 1995, the number of farms in Israel plummeted from 43,450 to 25,900. By 1999, 70 percent of the 80,000 people who worked in farming (3.3 percent of the labour force) were hired labourers.[11] This did not help the troubling pathology of double-digit unemployment in Israel that resulted from *Al Aqsa Intifada* and associated political turbulence after 2000. In many areas, the foreign Thai farm workers vastly out numbers host land owners. These migrants joined Israel's workforce, when their predecessors, Palestinian day labourers were perceived as a security threat or became unreliable due to mounting political tensions and violence. In short, by most estimates, only some 20 percent of Israelis living in rural areas work as farmers. In as much as Israel's population has increased 6-fold over the past six decades, the drop in the percentage of the workforce engaged in agriculture is far more dramatic (Kimhi, 2004).

In 1958 the number of persons employed in the agriculture sector was 110,000 and it reached its peak in 1961-62 when it reached 125,000.From then onwards there was decrease in the persons employed in agriculture because of the reasons as mentioned above. And during 1998, this dropped to 72,000 **(Table.2.6). As Figure 2.2** clearly shows there is a steady decline in the persons employed in agriculture from the establishment of the state. .In 2004, 49,000 Israeli residents were employed in agriculture (including supporting services), a decrease from 70,000 in 1990. Their share in total employed workforce was just two percent in 2004, a decrease from 4.2 percent in 1990.

The percentage of persons employed in agriculture in Israel is one of the lowest in the world, resembling that of the United States of America and Canada. By comparison, in Greece the share is 15 percent and in Jordan 10 percent. If one compares the percentage of all employed persons in different industries, it is four percent in accommodation services and restaurants, five percent in constructions, 13 percent in education and 16 percent in manufacturing. Indeed fifty-seven percent of all persons employed in agriculture work in farms that grow plant crops. In addition to Israeli residents, there were 26,800 foreign workers employed in agriculture (employee jobs) - 24,500 from other countries and 2,300 from the Palestinian Authority.[12]

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[11] For Details refer to Sheshkin, Arieh and Arie Rage, (2001), "Israel *Agriculture, Facts and Figures,* Ministry of Agriculture, December, p.3.

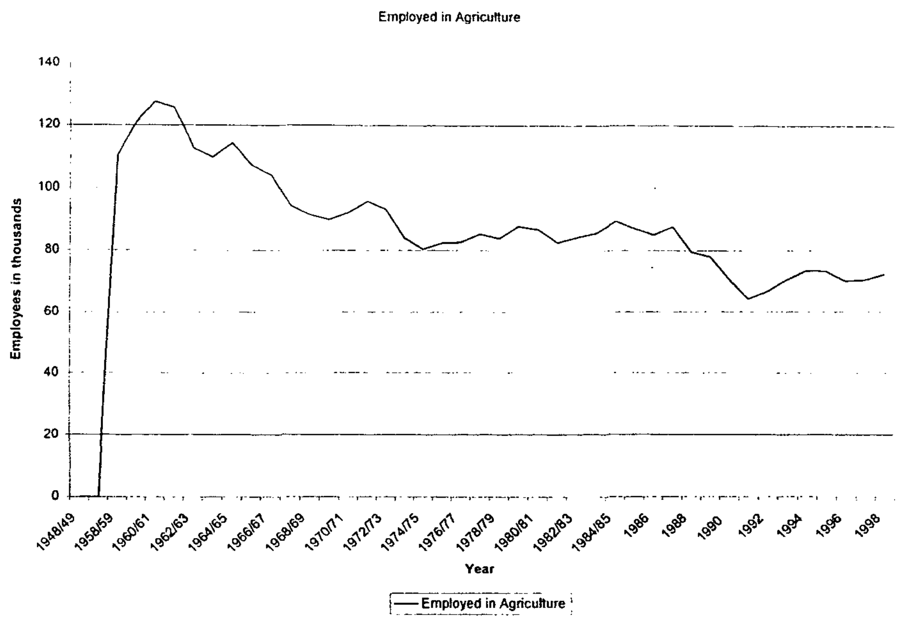
[12] For details also refer to Agriculture in Israel, 2004, Central Bureau of Statistics, Statistilite No.55, pp.1-2,www.moag.gov.il, accessed on 11 July 2008.

Table.2.6. Number of Persons Employed in Agriculture (In Thousands)

Year	Employed in Agriculture	Year	Employed in Agriculture
1948/49	..	1977/78	85.3
1949/50	..	1978/79	83.8
1958/59	110.4	1979/80	87.7
1959/60	121.1	1980/81	86.7
1960/61	127.6	1981/82	82.5
1961/62	125.9	1982/83	84.2
1962/63	112.6	1983/84	85.6
1963/64	109.9	1984/85	89.4
1964/65	114.4	1985/86	87.0
1965/66	107.4	1986	84.9
1966/67	104.1	1987	87.6
1967/68	94.3	1988	79.6
1968/69	91.3	1989	78.0
1969/70	89.8	1990	70.9
1970/71	92.0	1991	64.3
1971/72	95.6	1992	66.9
1972/73	93.1	1993	70.7
1973/74	83.9	1994	73.6
1974/75	80.4	1995	73.5
1975/76	82.4	1996	70.3
1976/77	82.6	1997	70.6
		1998	72.5

Source: Central Bureau of Statistics, Statistical Abstract of Israel, 2001.Table.13.1

Figure.2.2. Number of Persons Employed in Agriculture (In Thousands)



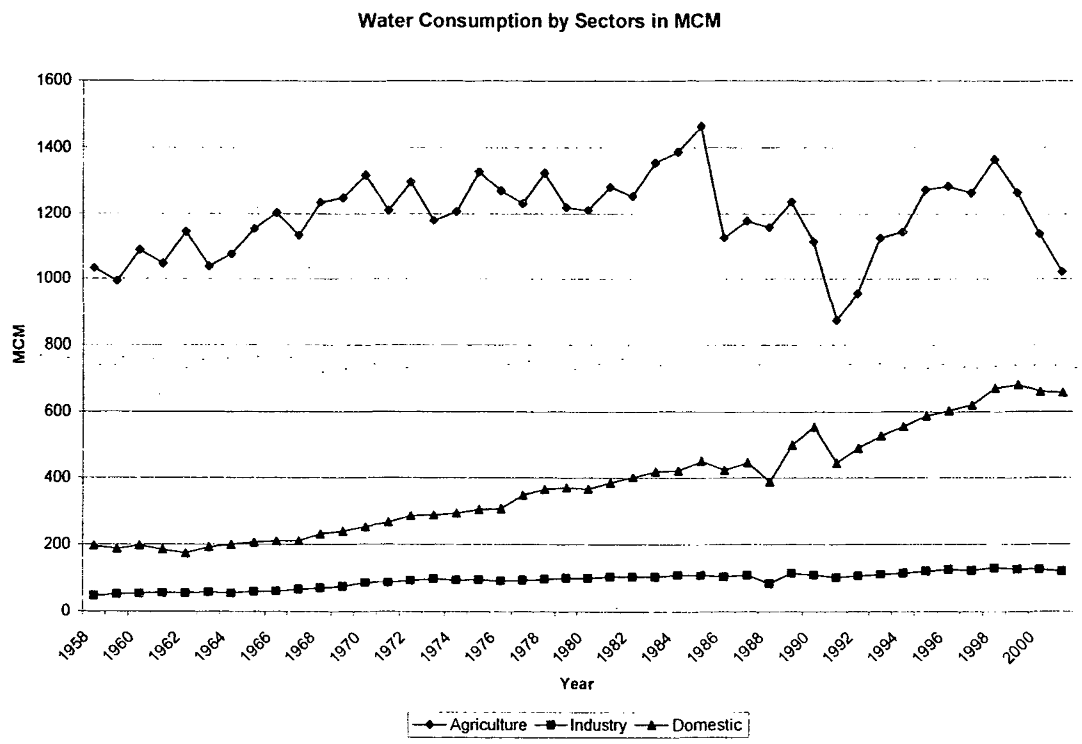
Source: Adopted from Table.2.6

2.5. The Shrinking Water Consumption

Agriculture has historically used around 80 percent (**Table.2.7**) of the water but use has been decreasing since the mid-1980s. Reduced potable water allocation to agriculture has become a primary mean of dealing with increased scarcity and rising household and industrial demands. In recent years, for 50 percent of its total demands the agricultural sector relies on recycled and saline water. Interestingly, decreased use of potable water in the agricultural sector has not been accompanied by a decrease in the overall value of agricultural output. In fact, absolute agricultural water use has declined even as a share of policy-imposed water use quotas. Farm water quotas were reduced in 1991 as a result of drought but water use did not increase accordingly when quotas were again increased. Beyond the continuous increase in efficiency in the use of each unit of water, this reduced use relative to quota is explained by changes in the agricultural water pricing structure and by the fact that price of water in agriculture rose 100 percent in the last decade.

For agricultural users, there are price steps, where up to certain level of water consumption a base rate is fixed and above which the rate of water increases to certain quota, but the quantities to which they apply are determined by farm-specific quotas. Availability of water beyond allocated quota is not guaranteed, but the "quotas" are not constraints. Farms can, in most cases, use more than their quota but a higher price is paid for over-quota use and a lower price is paid if use is sufficiently less than quota. Since each farmer is free to adjust use within these intervals, each farmer's marginal price bracket tends to reflect the true marginal value of water on that farm (unless the quota is not fully used). Most importantly, individual quotas serve to differentiate water prices among users because they determine the levels where rate steps occur.

Figure.2.3. Consumption of water by Sectors (MCM)



Source: Adopted from **Table.2.7**

If one looks at the water consumption by agriculture sector (**Table.2.7**), there is a major decrease of quantity of water used. For a decade from 1958 to 1968, agriculture consumed around 80 percent of the total quantity of available water in spite of the less availability of the water resources during that period. After the 1967 war and the capture of the Golan Heights, and construction of National Water Carrier, Israel managed to increase its total available water for different sectors. This increasing quantity in water resources lasted till 1975 and after that due to fluctuation in the annual precipitation and drought, there was fluctuation in the total quantity of available water. But during these periods the demand for agricultural water did not show much decrease in demand. If one looks at the **figure 2.3** till 1985 there was an increase in consumption by agricultural sector but thereafter there is a gradual decrease. This is mainly because of the improved irrigation system, cutback in water quotas and increasing demand from other sectors like domestic and industry.

The domestic sector which consumed around 15 percent of water during 1958, is consuming around 35 percent of water during 2001 (**Table.2.7**). Comparatively the agricultural sector which consumed 80 percent of water during 1958 dropped to 56 percent during 2001.This clearly shows the decreasing trend in consumption of water by the agricultural sector.

Table.2.7.Consumption of Water by Sectors 1958-2001 (MCM and Percentage)

Water consumption from 1958 MCM					Consumption in Percentage		
Year	**Total**	**Agriculture**	**Industry**	**Domestic**	**Percent of Agriculture**	**Percent of Industry**	**Percent of domestic**
1958	1274.3	1032.3	46.1	195.9	81.01	3.62	15.37
1959	1230.1	993.2	51.0	185.9	80.74	4.15	15.11
1960	1338.0	1087.0	54.0	197.0	81.24	4.04	14.72
1961	1287.0	1047.0	56.0	184.0	81.35	4.35	14.30
1962	1373.1	1144.2	55.1	173.8	80.32	4.01	12.66
1963	1288.4	1038.6	57.2	192.6	80.61	4.44	14.95
1964	1328.9	1075.4	54.4	199.1	80.92	4.09	14.98
1965	1418.5	1152.9	59.2	206.4	81.28	4.17	14.55
1966	1474.5	1203.0	60.8	210.7	81.59	4.12	14.29
1967	1410.6	1133.3	66.0	211.4	80.34	4.68	14.99
1968	1536.8	1235.4	70.2	231.2	80.39	4.57	15.04
1969	1563.9	1249.3	74.9	239.7	79.88	4.79	15.33
1970	1659.0	1319.0	86.3	253.7	79.51	5.20	15.29
1971	1564.8	1210.1	87.1	267.6	77.33	5.57	17.10
1972	1675.6	1297.3	92.4	285.9	77.42	5.51	17.06
1973	1565.1	1179.9	97.0	288.2	75.39	6.20	18.41
1974	1596.2	1207.1	94.4	294.7	75.62	5.91	18.46
1975	1727.8	1327.9	94.5	305.4	76.85	5.47	17.68
1976	1669.7	1271.2	91.2	307.3	76.13	5.46	18.40
1977	1673.4	1231.5	94.3	347.6	73.59	5.64	20.77
1978	1786.7	1325.0	96.2	365.5	74.16	5.38	20.46

1979	1690.1	1220.0	100.1	370.1	72.19	5.92	21.90
1980	1678.9	1211.6	99.70	367.6	72.17	5.94	21.90
1981	1769.7	1281.7	103.0	385.1	72.42	5.82	21.76
1982	1758.7	1254.6	103.2	400.9	71.34	5.87	22.80
1983	1877.8	1355.7	103.2	418.8	72.20	5.50	22.30
1984	1920.1	1388.7	109.0	422.4	72.32	5.68	22.00
1985	2024.3	1464.7	108.1	451.5	72.36	5.34	22.30
1986	1652.2	1125.3	103.8	423.1	68.11	6.28	25.61
1987	1732.7	1178.7	107.5	446.5	68.03	6.20	25.77
1988	1629.4	1157.8	83.00	388.6	71.06	5.09	23.85
1989	1850.8	1236.3	113.8	500.6	66.80	6.15	27.05
1990	1776.1	1113.0	108.4	554.8	62.67	6.10	31.24
1991	1419.9	874.80	100.4	444.8	61.61	7.07	31.33
1992	1551.3	955.30	105.8	490.1	61.58	6.82	31.59
1993	1762.4	1125.4	110.0	527.0	63.86	6.24	29.90
1994	1813.0	1143.6	113.9	555.5	63.08	6.28	30.64
1995	1981.3	1273.8	119.4	588.1	64.29	6.03	29.68
1996	2012.7	1284.3	124.4	604.0	63.81	6.18	30.01
1997	2007.8	1263.8	122.8	621.2	62.94	6.12	30.94
1998	2165.8	1364.9	129.2	671.7	63.02	5.97	31.01
1999	2072.9	1264.6	126.5	681.8	61.01	6.10	32.89
2000	1923.7	1137.4	124.2	662.1	59.13	6.46	34.42
2001	1800.4	1021.9	120.1	658.4	56.76	6.67	36.57

Source: Demand Management Division, Ministry of National Infrastructure and Water Commission, December 2002, pp.14 , http://gwri-ic.technion.ac.il/pdf/wcom/demand.pdf, accessed on 27 January 2008.

Growing water scarcity and price inequities have led to questions regarding agricultural water subsidization and social efficiency of the agricultural sector under its present structure. The drought of the early 1990s suggests potential for allocation of water away from agriculture. Largely because of successive droughts in 1990 and 1991, the real price of water to agriculture was increased and quota was reduced as a means of dealing with the temporary shortage. Some 47 percent increase in agricultural water prices occurred from July 1990 to May 1992 for use levels at 80-100 percent of quota, suggesting a substantial reduction in the indirect agricultural subsidy (Just, et al., 1999). In the last few years water quotas were cut by at least 40 percent. However, many farms that were able to adjust to the progressive pricing schedule attained a lower water price bracket by reducing their use relative to quota. The decline in national agricultural water use as a share of quota dropped from 89 percent in 1990 to 70 percent in 1992 thereby suggesting that many farmers moved to lower price brackets. Thus, the marginal water price (averaged among all farmers) increased less than the 47 percent increase in price schedule. Agricultural prices for 2005 are summarized in **Table 2.10** highlighting the quota level.

Changes in recent years in water used in the agricultural sector indicate that farms do respond to changes in price. For example, an increase of 11.7 percent in water prices resulted in a 2.4 percent increase in quantity demanded in 2003 relative to previous year. In 2005, an increase of 12.4 in water prices created a greater impact and reduced demand by 2.3 percent relative to previous year (*Statistical Abstract of Israel*, 2006). This price increase kept farms at 74.5 percent use of water out of the total allocated quotas for 2005. Total value of water as total input in agriculture was 7.9 in 2003 and raised to 8.9 in 2005, increasing the significance of water in the farmers' water budget and hence the create motivation for saving (*Statistical Abstract of Israel*, 2006). To overcome the increase in water scarcity, substantial public investment took place in highly efficient irrigation technology when quotas were decreased and a progressive water pricing schedule was introduced. Computerized sprinklers and drip irrigation systems have led to increasing efficiency of water use in agriculture. Water saving technology has evidently caused a decline in agricultural water demand.

Israeli agriculture has been able to reduce water consumption substantially over the years without a loss in agricultural production. For example, between 2000 and 2005 fruits sector that was exposed on average to 35 percent cut in water quotas increased its production by 42 percent. Whether agricultural demand for water will continue to decline depends both on opportunities to expand use of currently available irrigation technologies and on discovery of new irrigation technologies. It also rests of the discovery of new sources of recycled or saline water, as in the case of Citrus where the majority of the plantations are now been irrigated using recycled reclaimed water or the case of fish growing using saline water. These two examples represent the ongoing effort and a recent decision to further enhance government support (*Statistical Abstract of Israel*, 2006) in increasing the added-value created by unit of mobilized resources by developing new reclamation plants for recycling water for irrigation, improving banned wells and increasing the use of marginal water for irrigation.

2.6. The Shrinking Agriculture Export

By 1960 Israel had become self-sufficient in food production, although its population had doubled twice in twelve years of statehood. The yields still continued to grow. Export markets provided a continuously steep demand curve, even relative to the general economic growth. During the 1950s, some half of Israel's total exports were agricultural products, but this dropped precipitously to five percent by 1966 (Kimhi, 2004) Israeli flowers, fruits and vegetables continue to do very well in the European market and niche products, such as dates and on occasion even winter onions brought in considerable foreign currency. The trouble is that this dependency on foreign markets made the capital intensive Israeli farmer vulnerable to price fluctuations. Until the 1980s, Israeli agriculture was among the most subsidized in the world, with the full value of support exceeding the 80 percent European subsidy levels. But that decade saw a dramatic change in public policy. With the drop in government subsidies, relative profitability of Israeli produce tumbled, and farm operations often had difficulty competing with fruits and vegetables where government subsidies were enormous. Even more importantly, there was huge drop in prices on the world market for Israeli agricultural products, far greater than that in the domestic Israeli market. With free trade agreements fuelling Israel's overall economy, the new, unfettered competition with subsidized European produce has put some parts of Israeli agriculture at a distinct disadvantage (Tal, 2004: 21)

Table.2.8.Exports of Main Agricultural Products in Thousand Tonnes

Year	Exports of Main Products (Thousand Tonnes)				
	Fisheries	Flowers and Garden Plants	Field Vegetables	Other Plantations	Citrus
1948/49	-	-	154.6	-	-
1949/50	-	-	167.3	-	-
1958/59	2.10	-	376.5	3.3	1.3
1959/60	6.80	-	398.0	3.7	3.7
1960/61	14.2	-	331.1	2.9	4.0
1961/62	12.3	-	349.2	1.7	13.7
1962/63	14.8	-	504.8	1.6	11.7
1963/64	17.7	-	454.3	2.1	3.0
1964/65	16.9	-	526.6	0.8	8.2
1965/66	21.2	-	581.9	0.9	9.2

1966/67	16.0	-	664.6	1.3	4.3
1967/68	9.40	-	737.9	1.9	8.2
1968/69	14.0	3.40	697.5	18.8	5.0
1969/70	18.0	2.50	815.7	28.0	9.90
1970/71	18.2	4.40	858.5	37.6	12.3
1971/72	15.9	7.50	859.0	48.2	13.2
1972/73	8.70	7.80	776.9	36.5	29.3
1973/74	10.0	10.6	818.5	42.1	11.2
1974/75	17.2	13.4	926.9	53.2	11.2
1975/76	21.2	15.0	955.8	50.5	23.0
1976/77	20.3	18.7	921.6	47.4	19.4
1977/78	21.0	19.7	898.0	62.6	20.8
1978/79	25.5	28.2	964.6	52.4	22.9
1979/80	32.2	26.1	854.7	43.3	7.70
1980/81	32.8	63.0	821.0	54.2	18.7
1981/82	35.9	33.0	760.7	45.2	31.3
1982/83	30.1	49.7	700.7	42.6	16.6
1983/84	23.0	42.6	586.8	56.0	37.7
1984/85	32.4	60.4	544.3	50.3	33.6
1985/86	39.6	53.1	537.9	48.5	30.5
1986	23.8	52.6	537.9	13.7	23.6
1987	18.6	90.0	570.5	10.1	30.8
1988	15.9	26.7	470.3	11.6	29.7
1989	21.0	12.4	351.7	11.7	27.4
1990	17.7	35.2	461.9	12.4	41.1
1991	24.7	38.6	327.8	14.1	28.2
1992	22.9	52.5	324.9	17.0	25.9
1993	26.3	27.1	253.8	21.0	37.1
1994	21.3	28.6	255.8	19.6	24.3
1995	31.2	38.8	333.4	17.5	30.4
1996	29.0	54.4	338.6	24.0	93.0
1997	27.7	46.6	338.6	20.7	33.2
1998	29.7	32.4	330.4	18.8	58.0

Source: Statistical Abstract of Israel (2001), Table.13.1.

Note; 1948/49 to 1985/86 is Agriculture Year and 1986 to1998 is Calendar year.

If one examines Israel's agriculture exports, the major products have been citrus, flowers and garden plants, field vegetables, other plantations and fisheries. Among these, field vegetables occupy a huge share, because their production has tremendously increased in the past few years because of the major shift of farmers from field crops to vegetables. Even the vegetables export which peaked during 1970s shows a decline afterwards. This could be attributed to water quota cut back and increase in domestic demand because of increasing immigrant population. Flowers and garden plants export started only after 1976 which were mainly exported to European countries. During mid 1980s the export reached maximum while suddenly it dropped to 12 tonnes in 1989.This can be connected with the failure in monsoon and climatic conditions. Cultivation of citrus orchards in Israel is entertained well mainly because of the Mediterranean climate that prevails along the north western country. The production of citrus is encouraged in many ways and in particular to reduce water consumption which is the main motto of the water policy in Israel. So gradual reduction in export of agriculture products can be attributed to increasing domestic demand, less allocation of water to agricultural crops, increasing price of water to agriculture, and decreasing market in the world arena **(Table.2.8).**

2.7. Increasing Water Price

Farmers' water demand is responsive to prices. The 1959 Water Law, which had been enacted under entirely different circumstances, authorized the Agricultural Minister to levy charges to recover the cost of supplying the water. Furthermore, every price change had to be approved by the financial committee of the Knesset, where the government encountered a powerful agricultural lobby. If one examines the structure of pricing, water is metered and is charged according to the volume actually used. The pricing structure changed in the late 1980s, as part of a new water demand management policy, to an increasing block tariff that intended to achieve efficient water-use patterns. Currently, water prices vary widely across and within sectors and across regions depending upon local agreements and national policy for development of rural areas. Water prices differ among users in three ways: (i) agricultural users pay lower prices than industrial users who pay lower prices than households; (ii) prices differ among regions in ways that are consistent with water transportation costs (with some minor exceptions); and (iii) consumers face an increasing block-rate pricing structure whereby higher prices are paid at higher levels of consumption.

The increasing block tariff for agriculture is based on three levels of quotas of fresh water that are announced annually and prices of recycled water are set lower, to encourage farmers to increase use for recycled water. Domestic users pay three different rates according to three levels of quantities used and industrial users pay a fixed price according to permitted quota. Beginning from 2007, as part of a new Economic Arrangement of the Water Sector, water producers are charged Extraction Levy. An extraction levy, once set properly, reflects scarcity of water resources, and together with the production and distribution costs it is possible to set the water prices that reflect the true value of water. The economic rationale behind this new water demand management approach is to correct the market failures in the water sector and to prevent over extractions from the aquifers and to supplement other administrative tools (quotas) along with subsidized tariffs and levies. While setting the economic mechanism and the structure of the extraction levy, the new Economic Arrangement sets two leading goals:

(a) domestic and industry – creating a management tool for the overall aquifer production using economic incentives, creating incentives for self-water-producing local municipalities to connect to the national water network to increase reliability in supply and reduce the chance of shutting down sea water desalination plants (especially in the winter) and to avoid scarcity, to regulate among production sources according to the needs of the water sector while avoiding scarcity, especially to regulate production from aquifers from winter to summer and rehabilitation of the coastal aquifer by reducing over extraction that originates from economic considerations and

(b) agriculture - encouraging farmers to switch to recycled water, using efficiently the nation's water resources, creating tools to manage overall water production using economic incentives, creating tools for regional management of water quantity and water scarcity, encouraging the development of new water sources and agricultural preservation and the preservation of nature and landscape (*Knesset*, 2002: 111)

In its quest to rationalize water consumption, while adhering to the spirit of the law of preventing the crowding out of small, financially fragile farmers, in 1991 the government established the increasing block-rate tariff. According to the ordinances there are three tiers, which are determined by historical quotas. The lowest price block is applied for consumption of up to 50 percent of the fixed quota. The medium tariff is levied on consumption between 50 percent and 80 percent of the quota and consumption above 80 percent is charged the highest price block. Using historical quotas as benchmarks for block price creates exogenous variation across farmers regarding the price schedules.

The relative prices of the various tiers have changed over time, reflecting a dynamic political compromise between the farmers' lobby and the government on the one hand, and varying amounts of precipitation on the other. Rainfall has a significant negative effect on water demand. This variable indicates the amount of rainfall during the months of April and October. In Israel, there is virtually no rain between May and September, which is when crops are irrigated extensively and there is abundant precipitation between November and February, during which time there is no irrigation at all. During the months of April and October rainfall is spurious with high variability. Therefore, relatively high precipitation levels during April and October reduce irrigation during those months and thereby annual irrigation. As expected, more rain during those months significantly reduces farmers' annual irrigation levels.

With the beginning of the drought years since 1999, based on the crop composition of the farms, agricultural water cuts were made. The cuts range from 20 percent to 70 percent of the basic allocation (1989 quantity).The extent of cut is made according to the various kinds of crop to minimize the damage caused by the cuts. The Perennial crops (orchards) and capital intensive crops (greenhouse) are subjected to minimum cuts. The maximum cut is executed for cotton and field crops. The cut for livestock is nil whereas the cut for field crops is the maximum and it is 100 percent **(Table.2.9)**.Since climatically Israel is well suited for orchards and citrus crops the cut for this segment is to an extent of 35 percent whereas for vegetables, fodder (both consume relatively higher quantity of water) and field crops, the cut is 70 percent, 75 percent and 100 percent respectively.

Table.2.9. Water Cut in Various Crops (In Percent) 2001

Various Crops	Cut in Percentage
Livestock	0
Flowers in green houses	30
Orchards, Citrus, Vegetables in Green House	35
Flowers in Net Houses	40
Bananas, Fishponds	50
Vegetables	70
Fodder	75
Field Crops	100

Source: Demand Management Division, Ministry of National Infrastructure and Water Commission, December 2002:27.

Because water is the highest valued input to the Israeli economy, many feel it should be priced accordingly. Most obviously, those who use water should pay the full cost, capital as well as operating, to extract, treat as necessary, and deliver water. Less obviously, price structures should reflect the long-run incremental or marginal cost, which is the cost of supplying the last unit of water demanded. In this way, users will be forced to recognize the cost their demand imposes on the water-delivery system. When the system is operating correctly, the same principles mean that prices will also reflect opportunity costs, or the value of water in alternative uses. Although an exception to full opportunity cost pricing may be made on the grounds of equity for direct household consumption, the quantities needed to provide everyone with enough water for basic needs are so small relative to other uses that they have little effect on final results.

The same principles of pricing water as an input also argue for charges for disposing of wastewater. Appropriate charges would vary by volume and toxicity of the discharge, with some credit offered for those wastes, such as sewage, that have value in themselves. As with water, the objective is to ensure that households, industrial firms, and farms take account of the cost their operations impose upon the system. Unfortunately, charges cannot be applied very effectively to non-point sources of wastewater, such as runoff from farms. Farmers, however, can pay a fee to reflect the degradation in quality that occurs before the runoff reaches a watercourse or aquifer. The rationale for pricing water in a way that reflects its true cost and is supported by a great deal of evidence (Brooks et al. 1990; Postel 1993). The essential point is that, beyond the amounts needed for basic human and household needs, water demand is elastic, and notably so in the case of irrigation. If water is cheap, more will be used; if it is expensive, less will be used. If discharge is cheap or unregulated, wastewater flows will be high; if expensive, flows will be reduced. Neglect of the elasticity of water demand in pricing structures makes the whole water system inherently inefficient from an economic perspective. The low prices create excessive demand for water supply or discharge and force up government expenditures to provide infrastructure to meet this demand and inhibit conservation and recycling efforts.

An ideal pricing system for water includes two elements: one is a charge per cubic metre consumed and the other is a fixed charge per month. The fixed charge covers hook-up costs and other overhead needed to operate the system. The charge per unit used can be set in many ways but ideally equals the marginal cost of water supply. Assuming increasing costs of supply, which is the case throughout the West Asian region, most economists would favour a price structure in which unit charges for water increase with consumption, commonly referred to as increasing block rates (Brooks et al. 1990). The price structure can be made to reflect marginal costs even more closely by increasing prices during the summer when demands tend to peak and supplies come from more limited and expensive sources. Alternatively, charges could be reduced for users who can use water during off-peak periods or who can accept lower quality water that requires less treatment.

Any approach to efficient price structures for water requires that meters to measure water volume, and other meters to measure at least the volume of wastewater, be installed at every billing point. Fortunately, water meters are ubiquitous in Israel. They are found on a unit-by-unit basis within apartment buildings and (for control if not billing purposes) on a process-by-process basis within some industrial plants. Farms are also metered for water use, but the low prices for water mitigate the effect. Wastewater meters are less common, and charges for wastewater disposal are only now being considered.

Table.2.10. Agricultural water prices (US$/m3 at 2005 prices)

Level (percent of total quota)	1995	2005
A (50 percent)	0.165	0.282
B (30 percent)	0.199	0.335
C (20 percent)	0.267	0.441
Mean	0.196	0.330

Source: Ministry of Agriculture, 2006

Rates of cubic meter of marketable agricultural water are progressive based on three levels of quotas (**Table.2.10**). This structure was set in order to create incentives for farmers to use water efficiently.

During the first five decades of its existence, water prices in Israel were based on the real costs of the water supplier and on price regulations according to the Water Law. There were two failures; first, the shadow price of water was not taken into account in pricing and second, water associations that provided water from surface water sources paid especially low prices that encouraged unchecked consumption. Ever since the water crisis of the 1990's, and the establishment of the Knesset commission of inquiry on the water economy, water prices were raised for all sectors. As part of the plan for revitalizing the water economy, it was decided in 2000 to raise water prices to encourage conservation and efficient use of water. Thereafter, water prices for domestic consumption rose by 0.5 NIS (11 US cents) per cubic meter (CM). This price hike did not lead to water conservation however (IUED, 2004) because the price raising policy actually hurt the public that did conserve water, the poor population. In the Economic Arrangements Law for 2001 it was proposed to raise prices for domestic consumption again, by NIS 0.23 (5 US cents) for every cubic meter , uniformly for all domestic consumers, and not differentially in a manner that might have hurt poor consumers less. As a result the price of water for the thrifty consumer or poor population were raised by 29 percent, while prices for consumers who owned swimming pools rose by only 13 percent during those same five years.

Guaranteeing minimum water supply at affordable prices though 99 percent of Israeli residents receive flowing freshwater into their homes, the issue of pricing and water quality remain of high concern. There is no allocation of water at affordable prices for a basic quantity for drinking, cooking and sanitation; and the quality of water supplied to homes does not always conform to even Israeli drinking water standards. The better off Israeli population has turned to purchasing water purification systems or buying bottled water for drinking and cooking. Populations that do not receive flowing water to their homes regularly include: Bedouins in the unrecognized villages in the Negev; and residents of poor local authorities, the water supply of which is cut off by the water company *Mekorot* when the municipality fails to pay its water debt to the company. (Plaut, 2000:15 and16)

Therefore, none of the component is supporting the growth of agriculture or favour more demand of water at low prices. The land area under agriculture is shrinking because of varied land use pattern, including increasing population and demand for more built up areas. To facilitate infrastructure development more agricultural land is converted, and industrialisation and urbanisation demand more land area. In agriculture there is a major change in cropping pattern; field crops are losing their importance because of more demand of water and as a result, farmers are switching over to crops which demand less water like citrus, vegetables and flowers , which can be grown in green houses with less water. These lead to a shrink of the labour market. The number of persons employed in agriculture sector started declining because of the declining importance of the sector in the local economy as well as in the global market.

The shrinking consumption of water by the agriculture sector also clearly shows the declining importance of this sector in water policy when compared to the other sectors. Though agriculture sector is consuming the major share of water compared to domestic and industrial sectors, the consumption is decreased over years. This can be attributed to the increasing price of water, decreasing water quota for agriculture and less allocation of water. The export of agriculture products also decreased because of increasing local consumption and decreasing competitiveness in the global market. The export items also show a major difference where only flowers and fruits occupy a major share while other products are loosing their price competition in global market. So on the whole agriculture sector is loosing its importance but yet it holds a strong position in the making of Israel's water policy because of the strong agriculture lobby.

Chapter 3

Institutional Framework of Water Policy: Role and Failures

The water sector in Israel is dealt by multiple bodies. The multiplicity of Ministries as well as public bodies dealing with water issues, has constituted a problem since the establishment of the State, and as the years went by, their number also grew. Today there are several Ministries dealing with the water by law, other bodies that deal with it for functional reasons, and there are others who deal with water because of various interests. The multiplicity of agencies and absence of a clear hierarchy in determining water policy regarding, frequently causes not only duplicities and conflicts, but also difficulties in determining a clear and coherent policy, and in implementing decisions. Avishai Braverman[1] described the situation in the following words: "Israel's failure is a systemic failure. Israel has reached a situation in which it is a state that is incapable of operating for the implementation of public projects... One reason for why we have reached this situation is that we have a bureaucratic hell. We have so many Ministers, and so many persons who are in charge, that no one manages to cut the "Gordian Knot" (*Knesset*, 2002:45). Presently the water sector of Israel is dealt by 11 ministries and there are different government bodies which co-ordinates with the ministries. In addition to these government bodies, there are additional bodies that fulfil the staff and implementation of water policies in Israel.

The Water Law of 1959 vested ownership of all water resources with the state. It also outlined the structure and function of the water policy making authorities. The water policy network comprises of Ministry of Agriculture, Water Commissioner, Water Council and a Knesset Sub-Committee for Water. Until 1996, the supreme authority for the formulation and implementation of water policy rested with the Ministry of Agriculture, which was responsible for setting norms and standards relating to water quotas, quality, price, supply and use. The head of the Water Commission, the Water Commissioner was appointed by the government upon the recommendation of the

[1] Avishai Braverman was President of Ben-Gurion University and gave this statement to the committee during 2001.

Minister of Agriculture. The Water Commissioner is authorised to co-ordinate and manage all water affairs, including development of new water resources, regulating water allocation and production and preserving water quality etc (Menahem, 1998:292).

In 1996, when the Ministry for National Infrastructure was formed, the water sector was taken away from the Ministry of Agriculture and transferred to the new ministry. The Water Commission and the Sea of Galilee Administration (Lake Kinneret) were transferred from the Agriculture ministry to Ministry for National Infrastructure. The latter has a decisive influence in laying down Israel's water policy and it is responsible for representing the subject in the government and to introduce regulations related to it. But, because it is not adequately amended and updated, the Water Law of 1959 still does not recognise the Ministry for National Infrastructures as the nodal authority for the water sector. As a result, the Agriculture ministry continues to be responsible for the distribution of water quotas to agriculture and water prices for agriculture (*Knesset*, 2002:45).

Water policy in Israel is characterised by a high centralised planning and management structure designed to cope with the basic shortage of water resources. Water policy making takes place in an institutional setting where all water resources are nationalised. If one looks into the theoretical considerations, the concept of policy networks refers to a horizontal coordinating process in which a stable and lasting relationship is formed between government actors and private actors, who together share a common policy focus. Networks comprised of members of Knesset and public officials on the one hand, and representatives of interest groups and other corporate actors on the other in the formation of public policy (Menahem, 1998:284).[2]

Policy networks helps for the interaction between governmental and non-governmental actors. and provide a framework for the formation of definitions of state interests. Atkinson and Coleman (1992) note the concepts of policy community and policy network brings individual actors to the centre stage. But the analysis of transactions and exchanges between individuals does not provide the link between the network on the one

[2] Also refer to Coleman.W.D and G.Skogstad (1990), "Policy communities and policy Networks: A Structural Approach" in Coleman and Skogstad, eds. *Policy communities and public policy in Canada.*

hand and process and outcome variables on the other hand. In order to bridge the gap it is necessary to integrate in to the analysis of networks institutional variables and ideological variables such as the intellectual foundations of dominant world views in particular policy domains (Atkinson and Coleman, 1992:161).

The study of policy networks in Israel throws light on the historic process of the founding of the state and the properties of the major political and economic frameworks. Its three main characteristics were the highly centralised and interventionist character of the state on the one hand, declining autonomy of the state on the other hand and the corporatist pattern of national policy making. Israel is characterised by high degree of governmental centralisation and active state involvement in all areas of life. The state controls a very high proportion of both natural and national resources, including widespread land ownership, numerous government owned enterprises and a massive public sector which provides a wide array of public services.[3]

Another important facet of the Israeli system is that the major frameworks of the political system and interest group structure, as well as the concentration of economic resources with the public sector, are all developments which preceded the founding of the state in 1948. Of the major importance was the General Federation of Labour (*Histadrut*) and since its foundation in the early decades of the century, it has functioned as an umbrella organisation for the labour unions with which most of the workers in Israel are affiliated. Until the late 1990s the *Histadrut* also owned and controlled economic enterprises which were and still are among the largest in the country. The *Histadrut* was identified with the dominant labour party and many of its leaders became the state leaders. The organisations centralised control over major economic power centres, as well as its political affiliation with the dominant party, significantly contributed to the state's control of resources (Menahem, 1998:289).

The public bureaucracy of highly skilled experts can play an important role in the process of defining state interests. In Israel, the civil service became the vehicle for fulfilment of the interests of the political parties. The basis for recruitment of personnel was political

[3] For details see ,Sharkansy, I. (1987), "The political Economy of Israel", Transaction Books, New Brunswick (United States). This continued until the 1990s when Israel began an active process of economic liberalisation and encouraged private ownership.

and establishment of adequate professional standards was thus impaired.[4]This close affinity between the *Histadrut*, the dominant political party, and the state, drove off other civil society actors, such as professionals, from the policy making process (Menahem, 1998:290). "The policy making in Israel has been characterised as representing a variant of "social democratic corporatism."[5] The Israeli model of social democratic corporatism is especially noted for the major role that is attributed to the political parties (Shalev, 1992:5-6).This involvement of political parties in the "societal bargaining" might create more favourable conditions for the operation of sectoral corporatism, in which legislators from the covering coalition often become the intermediaries between interest groups and state.

Water policy in Israel is not different and is deeply intertwined with agricultural policy, which has historically played a major role in the process of nation building. Within the Zionist ideological framework and practice, agriculture held symbolic importance for rebuilding the social structure for the ingathering Jews from the Diaspora and to inhabit the territory and ultimately to achieve the statehood (Shafir, 1989:32).Recently there is decline of the dominant ideology in Israel and the role of agriculture is reduced in the face of industrialisation and post industrialisation processes. But still the water policy in Israel continued to be seen as part of agricultural policy.

The water policy since 1948, can be separated into several periods. The initial period established the institutional framework and the water policy network. Water issues have always been the province of the Ministry of Agriculture, which handles water management and appoints key functionaries in the water economy. It also represents the main consumer group, the agriculture sector. In 1988, *Tahal* determined

Water allocations formerly set by the Ministry of Agriculture ('planned quotas') and the Water Commission ('licensing') were a direct consequence of decisions regarding development of settlement and agriculture. Water allocations to agriculture reached 1480

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[4] Also see Nachmias,D,(1991), "Israel's Bureaucratic Elie : Social Structure and Patronage" ,Public Administration Review, September/October and Sharkansy, I. (1987), "The political Economy of Israel" , Transaction Books, New Brunswick (United States?)

[5] In social democratic model, national trade union elites undertake to co-ordinate and limit workers demand on the basis of understandings or agreements with the state and organized employers. Broad socio-economic issues were negotiated among the government, the employers, and the representative of organized labour, the Histadrut.

MCM in 1948/85, even though it was impossible to guarantee even a steady average supply of 1300 MCM over the years. Today, no stable supply may be promised to agriculture, even with balanced pumping from aquifers, because of the lack of reservoirs for long-range control (Dery and Salomon, 1997:103).

As a result, economists tend to focus on water prices as a main solution for the acute water crisis in Israel (Mizrahi,2004:276).The institutional framework for water policy formulation and implementation ,as formalised in the Water Law ,reflect the centralistic and interventionist character of the state .The close affinity between state elites and the leftist parties and the organised and collective agriculture sector found expression in the composition of the water policy network (Menahem,1998:292).

If one looks in to the public choice theory for analysing the process of public policy making, it explores the relations among three key players involved in any policy-making process, namely, politicians, bureaucrats and interest groups. Public choice theory integrates structural and individual aspects in the sense that the social reality is determined by the acts of individuals who are acting rationally to maximize their self interest under the influence of structural factors (Mizrahi, 2004:277).

Generally the state intervenes in public policy when a shortage of public good arises. The public also does not demand change until a catastrophe occurs. Most people prefer to gain or achieve things through the efforts of others leading to a collective action problem.[6] When one applies this to the water policy of Israel, the policy decisions regarding water supply are a public good from which anyone can benefit without being involved in the policy-making process. This provides motivation to become someone who relies on someone else to act, and as a consequence, none of the players works with the others to change the water policy. This result in the shortage of water policy in one hand and a lack of interest in generating public pressure to change the situation on the other (Mizrahi, 2004:277).

In the absence of demand by the general public, groups which can manage to overcome the problem of collective action to form the interest groups have significantly more power. These groups, who exercise significant influence over water policy, are

[6] For details refer to Olson 1965 and Taylor 1987.

traditionally members of the agriculture sector in Israel.[7] If one looks in to the influence of interest group in public policy, political economist tend to agree that the influence of one interest group in a specific policy dimension increases as there are few competitors attempting to pursue their interests with politicians. The area of water policy in Israel is characterised by passivity of the public, that is, there is no interest group competing with the agriculture sector. This passivity is explained by the fact that there is "low visibility" among the public regarding the possible solution for Israel's water problems. Added to this most Israeli citizens are not directly damaged by the water crisis to generate a collective action where people prefer not to pay the costs of struggle to obtain a public good that they do not see it as a highly beneficial for them , that is ,an efficient water policy. This means that the strength of the agriculture sector reflects lack of competition from other interest groups (Mizrahi, 2004: 281). The agriculture sector also had strong ties to the Labour party, which dominated Israeli politics until 1977. During the 1960s, those affiliated with the agriculture sector regularly constituted a third of the cabinet members in the government. Furthermore, in most cases the heads of state authorities dealing with water have been representatives of the agriculture sector.

Furthermore Mizrahi (2004) explains that the political-bureaucratic structure has a substantial impact on the ability of organised groups to pursue their special interests. The more decentralised the structure, the greater the impact of interest groups on public policy and the lower the impact of bureaucracy. In centralised systems like in Israel, the demands of the few interest groups are channelled through the bureaucracy and thus serve to further increase the level of centralisation. In other words, in centralised political-bureaucratic systems, bureaucrats can control policy-making processes, channelling them towards their own ends. And the politicians also attempt to control bureaucrats using political appointments and rewards for top administrators .This is more relevant in case of Israel's water policy, where the water commissioner is being

[7] For details refer to Rausser, G. C. and Zusman, P., (1991), Organizational failure and the political economy of water resources management, in: Ariel Dinar and David Zilberman (Eds.) The Economics and Management of Water and Drainage in Agriculture (Boston: Kluwer Academic Publications), pp. 735–758.

appointed by the Ministry of Agriculture and later by Ministry for National Infrastructure.

While it is possible to see a planned water policy in Israel since the establishment of the state, it was in the early 1970s that the shortage of water resources was publicly recognized. It was only in the early 1990s that this shortage was declared a ''water crisis'' and dealt with intensively by hydrologists, economists and bureaucrats. The peace process that started in the early 1990s added an international dimension to the crisis and consequently the water crisis has also become a major security issue.

The bureaucratic structure of water policy making was not exceptional when compared to other policy areas as it was also highly centralized and marked by intensive use of political appointments to control the water administration. By definition, political appointees are expected to serve the specific interests of politicians in the relevant policy dimension. In terms of water policy, most Israeli citizens have been passive, meaning that politicians were expected to assume that only citizens in the agriculture sector take water policy into consideration when going to the polls.

> Politicians have tended to provide the agriculture sector with the demanded rents, that is, subsidies, generous allocation and low water prices. In that respect, the interests of politicians in the area of water policy have been similar to those of the agriculture sector and were most likely to be best represented by representatives of this sector. Indeed, as previously mentioned, the managers of the water bureaucracy in Israel have generally been political appointees representing the interests of the agriculture sector. In that respect, the centralized system of water policy has been directed towards the interests of the agriculture sector, overruling professional water experts. As mentioned earlier, in the first three decades after the establishment of Israel, this kind of political control over the bureaucracy characterized most bureaucratic sectors and policy areas (Mizrahi, 2004:284).

3.1. Legislative Framework for Water

The core of Israel's water management legislation is the Water Law of 1959.A Water Commissioner, as the head of Israel's Water Commission, who reports to the Minister of Agriculture (and later of Infrastructure), is responsible for implementation of the act. The law denies private and riparian rights to water and claims that water resources are a public property subject to control by the State (Water Law, 1959). Under it, water resources are to be allocated to the most urgent and efficient uses only and every person is entitled to use water, as long as that use does not cause the salination or depletion of the water resource. Therefore, national water planning should follow the principle of maximum water conservation, optimum management of water resources and careful water allocation. The absence of private ownership of water is further provided for in Section 4 of the Law which states: *"A person's right in any land does not confer upon him a right in a water resource situated therein or crossing it or abutting thereon..."*

Contrary to legal concepts prevailing in many other countries, land ownership in Israel does not include the right to the water flowing through the land, beneath it or drawn from wells situated thereon. Water may be drawn from a well situated on a person's property only in accordance with a water production license, even if the water is intended solely for the landowner's own consumption. While the Water Law de facto expropriated any private ownership of water and water resources, the right to receive and use water has been *"Every person is entitled to receive and use water, subject to the provisions of this Law."* The right to water is not an absolute one but always applies for one of the purposes recognized by the Water Law. The purposes recognized by the Water Law for private right of water uses are domestic uses, agriculture, industry, handicraft, commerce, services and public services (Section 6). While the water source itself cannot be subject to private ownership, water production, pumping and supply equipment may be, and is in many cases, privately owned. Thus, once water is allocated, the water is brought to the end user through the private sector.

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

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

Water allocation to domestic users is through the Municipalities. The Municipality serves a dual function, as a consumer of water as well as the bulk producer/supplier and as a water supplier vis-à-vis all of the consumers within the municipal boundary. Before 1995, domestic uses were subject to quota allocations. Since that year quota allocations for domestic water use were abolished and a strict differential pricing mechanism was introduced. The rules concerning municipal supplies require that each consumer must have an individual water meter, and that water is charged for separately and not as part of the municipal levies. Industrial uses are subject to quotas based on water use tables for the various industrial uses and annexed to the Regulations. There are specific provisions relating to small consumers (that is, up to 5,000- 10,000 cubic metres per annum).

The water allocation system distinguishes between allocations for planned and non-planned communities. Water allocations for planned communities are based on the water needs defined in the agricultural plan for the community. Water allocations for non-planned communities are based on the type of agricultural growth, growth stage of the plants/trees, and geographical location of the plants/trees. The allocations are based on water needs in the various regions of the country and normally water would not be allocated to regions where a particular growth pattern is considered to be inefficient. In 1991 the Water Law was amended with a supplementary chapter on water pollution. The new rules reflect the growing importance of environmental protection in the use of water resources. Article 20 of Chapter Two of the law directly relates to prevention of water pollution. The Article states: "A person shall refrain from any act which directly or indirectly causes, or may cause, immediate or subsequent water pollution; and it shall be immaterial whether or not the water resource was polluted before the act." The law sets fine levels, establishes personal liability, empowers courts to impose cleanup expenses on polluters or to undertake cleanups, and enables citizens to initiate legal proceedings against offenders. The Minister of the Environment is authorized to protect water quality, to prevent water pollution, and to promulgate regulations on these issues. Section 1 of the Water Law lays down the underlying philosophy of Israel's approach to its water resources by providing that: "The water resources of the State are public property; they are subject to the control of the State and are destined for the requirements of its inhabitants and for the development of the country."

3.2. Other Laws and Regulations

3.2.1. Water Measurement Law 1955

A fundamental provision in the law is the obligation to provide a measured amount of water to each consumer. Payment for water used is based on water meter readings. The law grants the Water Commissioner the right to prohibit supply and consumption of water if a water meter is not installed, and to install a water meter on the account of whosoever was obliged to install one.

3.2.2. Water Drilling (Control) Law 1955

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

3.2.3. Local Authorities (Sewerage) Law 1962

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

3.2.4. Streams and Springs Authorities Law 1965

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

3.2.5. Prevention of Water Pollution (Rinsing of Containers for Spraying) Regulations, 1991

The regulations prohibit anyone from emptying or rinsing chemical and/or biological substances or their residues from sprayers, collection tanks or any other installations into a water source, either directly or indirectly. They set specific requirements on the sites, construction and operation of rinsing installations. Specifications are set forth on size, sealing, operation and maintenance of the reinstated collection tanks and evaporation ponds.

3.2.6. Prevention of Water Pollution (Spraying Near Water Sources) Regulations 1991

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

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

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

3.2.8. Prevention of Water Pollution (Usage of Sludge) Regulations 2004

These regulations, prepared by the Ministry of the Environment in collaboration with the Ministry of Health and the Water Council, are aimed at preventing water pollution and environmental degradation caused by improper disposal of sludge from municipal sewage treatment plants. The regulations, which came into effect at the beginning of 2005, require wastewater treatment plants to stabilize and treat the sludge they generate to be suitable for agricultural use and avoid soil deterioration. The regulations establish maximum limits for heavy metal and pathogen concentrations and odour limits on sludge designated for agricultural use, set recording and laboratory testing requirements, define specific uses for different classes of sludge (A and B), set limitations on areas of sludge use, and prescribe requirements for warning signs, transport and storage. Requirements for class A sludge, which is virtually pasteurized and highly stabilized, would come into force in 2008. Following are the maximum permitted values for heavy metal concentrations in treated sludge (in mg/kg of dry material): cadmium 20, copper 600, nickel 90, lead 200, zinc 2500, mercury 5, and chromium 400.

3.3. Organisational framework of Water Policy in Israel

As discussed above, the water policy network in Israel is influenced by political, bureaucratic and interest groups. If one examines the role played by each of them, there is high level of complexity and there is no proper delineation of work. The major components of the water policy is discussed below with the role of the different sectors involved in it. For the sake of clarity, they are discussed along functional rather than institutional lines.

3.3.1. Water Policy Formulation and Implementation

Until 1991 Minister of Agriculture was the supreme statutory authority charged with formulation of water policy in Israel, subject to oversight by the Knesset Finance Committee. The subordination of water policy to the Ministry of Agriculture has always been problematic, because of the natural tendency of the Ministry to act as advocate on behalf of farm interests, who consume around three quarters of all water. Hence there is an automatic conflict of interest at the heart of water policy (Plaut, 2000:5). The supreme authority for the formulation and implementation of water policy in Israel rests with the Minister of Agriculture, who is responsible for setting norms and standards relating to water quotas, quality, price, supply and use. The institutional framework for water policy formulation and implementation, as formalized in the water law, also re-elected or reiterate the centralistic and interventionist character of the Israeli State (Menahem, 1998:292).

The Water Commission, which operates within the framework of Ministry for National Infrastructures, performs the major role in formulating the water policy of Israel as well as the implementation part of it. Article 138 of the Water Law authorizes the Government to appoint a Water Commissioner on the basis of the recommendation of the Minister of Agriculture, in fact, the Minister for National Infrastructures, in consultation with the Minister of Agriculture. Since 1996 the Water Commission constitutes an integral part of the Ministry for National Infrastructures and the Commissioner is subject directly to the Minister for National Infrastructures (*Knesset*, 2002:37). The other functions of the Water Commissioner as prescribed in the law include, preserving the water resource, preventing contamination of the water, laying down norms and rules for the use of water and authorizing associations to set up and operate national and regional water enterprises.

According to the 1959 Law, the Water Commission was supposed to be composed two-thirds of representatives from the "public" (out of 39 commissioners). These "public" representatives are supposed to represent water "consumers," primarily farmers. In fact the "Agriculture Centre," the main lobbyist for the farm sector, is guaranteed 13 representatives on the commission. A water planning commission consisting of 11 professionals and representatives of the "public" was also created to oversee new water projects. The most important power of the Water Commission under the Water Law is its control over water quotas. Supposedly on the basis of serious research, the commission decides the norm of how much water is "needed" for any crop produced by farmers. Water quotas are in fact more a reflection of "entrenchment," essentially perpetuating the existing water allocation pattern, with small amounts set aside for planned future settlements and activities (Plaut, 2000:3).

Despite the various powers exercised by under the law, Water Commissioner's hands are tied at the implementation stage most of the time because of the multiplicity of the authorities that deal with the issue. Water Commissioner is forced to share the implementation of the task with many other bodies, sometimes in order to receive their approval so that they may fulfil their duty, sometimes for the purpose of consulting them, and sometimes to execute the task together with them. This combination of bodies, and the requirement to consult and receive the approval of an additional supervising body, constitutes a conspicuous characteristic in the water legislation. This has resulted in decision making on water issues involving many bureaucratic procedures, that cause a waste of precious time, and make proper functioning very difficult, especially in times of crisis (*Knesset*, 2002:37, 49).

3.3.2. Supply and Distribution

Actual supply and pumping of water in Israel is performed by *Mekorot*, a public corporation that pumps and supplies about 66 percent of the nation's water, including that drawn from the Sea of Galilee. The remaining 34 percent comes from small independent suppliers. *Mekorot* is also the official governmental body empowered to undertake development and planning of water sources. Much of the distribution of the supply takes place through the "National Carrier" system of aqueducts and pipelines opened in 1964. *Mekorot* is one of the larger enterprises in the Israeli economy and employs over 2,300 employees, which is huge in relation to most other Israeli companies. The ownership structure of *Mekorot* was changed in 1995. Until then, the government owned 70 percent of the equity shares of the company, the Jewish Agency held 13 percent and local authorities held 9.5 percent, with the remainder divided among others, mainly agricultural water consumers who received the shares as a "bonus" when they were allotted water rights. Actual control of *Mekorot* was exercised through a smaller set of "ownership shares" giving two-thirds control to the government and one-third to the Jewish Agency. In September 1995 the government bought out the shares of the Jewish Agency and now exercises complete control.

3.3.3. Water Quota, Subsidy and Water Price

The most important power of the Water Commission under the 1959 Water Law is its control over water quotas (Plaut, 2000:3). The Ministry of Agriculture was responsible for the water sector until 1996, when the Ministry for National Infrastructures was established. Since then the latter is responsible for the distribution of the water quotas to agriculture, and water prices for agriculture. Since agriculture is still the largest consumer of water (sweet water, brackish water and effluents), it is almost impossible to change anything in the water policy without the cooperation of the Agriculture Ministry, which, to a certain extent, represents the interests of the farmers. The Minister of Agriculture initiated the 2002 agreement among the Ministries of Agriculture and Rural Development and Finance, regarding far reaching reforms in the prices of water for agriculture - a reform that opened a new era in the water sector (*Knesset,* 2002).

A major budget item for the Ministry of Agriculture consists of these supports and subsidies but does not include debt bailouts for farmers or government investment grants. The result is that farmers are paying much too little for water to begin with, and many are also getting subsidies to cover this under priced water and cash compensation when their water allotment is reduced. In budgetary terms, water subsidy has been one of the most expensive forms of subsidization in Israel. Subsidization continues to be a major item in the water section of the central government's budget. In the 2000 budget for example, water subsidies grew in real terms. It allotted NIS 298 million (approximately $73 million) for direct water subsidization, which is about 27 percent of the entire water system governmental budget. Until 2000 the government also subsidized water in the form of reimbursing to local authorities in the form of VAT payments they paid for water consumption (Plaut,2000:12).

3.3.4. Water Quality, Preservation of Natural sources and Prevention of Pollution

The 1959 water law had few provisions that focused on improving water quality. However, the situation changed in 1971 as a comprehensive amendment on water quality was expanded (Tal, 1994:246). According to the law, the Water Commissioner has the right to issue orders to reduce pollution problems. One of them requires consumers to restore a water resource to its original state. "Allowing Orders" are the functional equivalent of discharge permits that require submission of sewage plans. The most draconian is the power granted the Commissioner to issue a "Stopping" Order, which literally turns off the taps for anything but drinking water (Water Law, 1971).

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

The Ministry for the Environment which was set up in 1988 is responsible for all issues concerning preservation of natural resources and prevention of pollution, including the contamination of water and the treatment of sewage. The Ministry of Agriculture gave its responsibility over the quality of the water, monitoring rivers, the Local Authorities and Sewage Law, and the River and Springs Authorities Law to the Ministry for the Environment. From the Ministry of Health it received responsibility to deal with sewage, except for laying down standards and approving plans. Despite the aforesaid, the powers of implementation in all these spheres are in the hands of the Water Commission. The Ministry of Health is responsible for the quality potable water and also for a proper separation of sewage from potable water. The Ministry also lays down the rules for irrigation with effluents to protect the potable water drillings, and sea from pollution by sewage, and to supervise the quality of fruits and vegetables irrigated with effluents. Despite these two ministries, the Water Commission is also responsible for preventing the contamination of the water as well as preserving the water resources (*Knesset*, 2002:46, 47 and 49).

3.3.5. Budget and Expenditure

The Ministry of Finance plays a central role in the water sector by means of two of its divisions: the Budgets Department, which approves or denies budgets to the various Ministries that deal with water and *"Mekorot"*, and the Accountant General's Department, which controls all Government expenditure in the sphere of water, and is responsible for issuing government tenders, including the tenders for the desalination of seawater and tenders for the importing water from Turkey. The Ministry of Finance has played over the years a central role, which has not always been constructive, in the struggle to cancel the water quotas for agriculture and subsidization of agriculture by means of the water prices, and in laying down the time tables and conditions for developing sewage treatment plants and the beginning of wide scale seawater desalination in Israel. Since the 1970s the Ministry of Finance has led the debate in favour of managing the water sector on a purely economic basis - in other words, on the basis of the principles of supply and demand. In a certain sense one could view the approach of the Ministry of Finance to the water issue as being based on narrow accountancy principles that do not take into consideration non-economic interests, such as ideology or foreign policy interests.

Within the framework of the leading role played by the Minister of Finance in the Ministerial Committee for Social and Economic Affairs, that deals *inter alia*, with the water sector, the Minister can have a major influence on the decisions taken by the Government on the subject (*Knesset*, 2002: 46). The Ministry of Finance is responsible for the overall budget and for disbursement to the various entities involved in water resource management. For years, representatives of this ministry have been opposing the establishment of desalination facilities and instead supported a policy of raising water prices for farmers as a means of saving water and making effective use thereof (Zaslavsky, 2001).

3.3.6. Security and Foreign Affairs

In the past, the Ministry for Foreign Affairs played an active role in the past in the sphere of water, regarding US mediation efforts between Israel and its neighbors regarding the distribution of the Jordan River waters and over American and other foreign assistance in the development of the water sector in Israel. Since the Madrid Conference in October/November 1991, the Ministry for Foreign Affairs has been a partner in all the multilateral and bilateral regional cooperation activities regarding water issues - not always in full cooperation with the other factors in the economy, that deal with the water issue. The Ministry of Defense was and remains, to a certain extent, involved in the issue of the water supply to the Palestinians and the Jewish settlers in the West Bank and the Gaza Strip. The Ministry of Defense also has an interest that Israel should reach an agreement with Turkey regarding the import of water. The Prime Minister's Office is also involved in issues connected with water, and can influence the policy in this sphere, both inside the country and on the international level. In 2001 a committee for the removal of blockages in the water sector was set up within the framework of the Prime Minister's Office, headed by the Deputy Director General of the Office (*Knesset*, 2002:47, 48).

3.3.7. Co-ordination among different Ministries

There are several bodies which bring about co-ordination among the various Ministries and other factors dealing with the water issue. This includes the Ministerial Committee for Social and Economic Affairs, Emergency Staff for the Water Sector, and Committee for the Removal of Blockages in the Water Sector. In March 2002 a team of Director Generals, headed by the Director General of the Prime Minister's Office, was established to deal with the import of water from Turkey. However, in practice, the coordination is faulty. These bodies are headed by different authorities; Ministerial Committee for Social and Economic Affairs by Prime Minister, Emergency Staff for the Water Sector, an inter-ministerial team by Director General of the Ministry for National Infrastructure and Committee for the Removal of Blockages in the Water Sector by Deputy Director General in the Prime Minister's Office. The Ministerial Committee does not keep up with what needs to be done; the Emergency Staff discusses important issues, but the main message to emerge from it's meetings is frustration from the difficulty in getting resolutions through the Government; while the Committee for the Removal of Blockages, is in a state of inner contradiction, since part of the blockages in the water sector are to be found in the Office in which this Committee was set up (*Knesset*, 2002:48, 80)

3.3.8. Advisory

Tahal as a water planning authority serves as a advisory body to the Minister of agriculture.(Menahem,2001:26) .The Water Council which was set up as a statutory body also advices the responsible Minister on water matters. Presently, the Council has 27-39 members and includes representatives from the government, Jewish Agency and the public. At least two thirds of the members of the Council are representatives of the public, who represent the water consumers and water suppliers. Half of these are representatives of the consumers, and majorities are representatives of the farmers. The Council is appointed by the government but in practice by the Minister for National Infrastructures, and its formal task is to advise the responsible Minister on various issues mentioned in the Law, such as the water sector policy, laying down norms and rules for the use of water, declaring rationing zones and approving plans for water projects, laying down rules for calculating the price of water, and preparing a list of public representatives to serve in the water court.[8] The Minister for National Infrastructures serves as chairman of the Council, while the Water Commissioner serves as his deputy, but it is the latter who runs most of its meetings (*Knesset*, 2002:83).

3.3.9. Planning and Making Master Plans

The Israel Water Planning Authority *Tahal* was originally a government corporation which was in charge of comprehensive planning and served as an advisory body to the minister. *Tahal* was established in 1952 and was privatized in 1996.It is also responsible for the preparation of Master plans of water sector in Israel. In the early years master plans were apparently taken more seriously. But when Yossi Dreizin gave a lecture at the symposium held by the Water Commission on the new master plan for development of the water sector in 2002, he explained the result of less importance given to it as,

"By the time the planner presented the plan, the decision makers changed, or the policy changed. The result was that when the plan was presented as a product... it suddenly transpired that it was irrelevant... (In addition) the plans were very rigid, were presented on paper, and were prepared with conventional tools, so that if it was necessary to adapt it

[8] The Water Law 1959, article 130a.

to policy changes, or different directions of thought to those that prevailed when work on the plan began, it would have taken a relatively long time to do".(Knesset,2002:56)

The master plan of 1988 prepared by *Tahal* for the then Water Commissioner Zemah Yishai, following the State Comptroller Report was shelved, primarily because it proposed cuts in the quantity of sweet water allocated to agriculture from 1.2 billion cubic meters in 1988 to 740 MCM in 2000.But the Planning Division of the Ministry of Agriculture did not take up the cut and ensured the supply of sweet water to agriculture in 2000, at a rate of 1.3 billion cubic meters per annum, including desalinated water. Thus the recommendation of the Master Plan was not accepted.

Again in 1994, upon the request of the Water Commissioner Gideon Tsur, *Tahal* prepared a new master plan which was updated in 1997.The new master plan presented three scenarios regarding the quantity of water that would be available in 2010, 2020, and 2040, and two basic approaches to water policy; one, termed "business as usual", and according to which decisions are taken on an administrative basis, while talking of security and social aspects into account, and another purely economical. The plan presented two policy proposals, which were based on the different basic approaches, in a situation of an intermediary forecast regarding the water potential. The plan was presented to the new/old Water Commissioner, Meir Ben-Meir, who shelved it soon after re-entering office following the 1996 elections, without explaining his decision (*Knesset*, 2002:56, 57, 58). The Planning division of the Water Commission presented another Master Plan (transition) for the development of the Water Sector in the years 2002-2010.

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

The Prime Minister is also involved in national and security decisions directly or indirectly related to water due to the extreme sensitivity of this issue.

Decision-making and management in the arena of water resources are impacted by many factors which ultimately determine the allocation of those resources. Management is greatly influenced by special interest groups, which can impose pressure on the government. For example, in principle the first priority for water allocation is domestic consumption, then industry and only after that, agriculture. However, in practice, priorities tend to be, first, agricultural consumption, then domestic consumption and finally industrial consumption.

3.4. Conflict between Ministries and other stakeholders

Israel's water economy is characterized by conflicts of interest between different Stakeholders. The main tussle between different ministries and other actors in water sector of Israel can be summarized as follows.

3.4.1. The Water Commissioner vs. the Ministry of Agriculture

The goal of the Water Commissioner is to protect water sources, and the Ministry of Agriculture works to supply water, with less of an emphasis on protecting water sources. The cutbacks in water allocations that are mandated during dry years delivers a shocking blow to the agricultural sector, especially because during dry years there is a need for more irrigation. The Water Commissioner is also interested in cancelling water subsidies and the Ministry of Agriculture or the farmer's lobby have objected.

3.4.2. The Ministry of Finance vs. the Agricultural Lobby

The Ministry of Finance is working toward cancelling the water allocations for agriculture and the subsidizing of agriculture through water prices. The Ministry is pushing toward a management policy based on economic considerations. The Agricultural Lobby takes a value driven view of agriculture, and fears that no new forms of subsidy for agriculture would emerge, and therefore has been unwilling to give up the subsidy through water pricing. In addition, the water allocation to agriculture gives farmers control over state assets, which they are not prepared to give up. But the Ministry of Finance is struggling to bring up all the regulatory measures which are needed for the economic growth of Israel. This brings great tussle between these two.

3.4.3. The Finance Ministry vs. the Environment Ministry and environmental NGOs

The Finance Ministry is over interested in the growth of GDP, and therefore activities that do not conform to this goal, are not its priority. Therefore, in its view, allocation of water to nature, as long as there is no proof of its contribution to the GDP, has no value. Environmental groups oppose this view, and see conservation of nature as having value for the residents of Israel, tourism development and future generations, and do not accept the purely economic view, that everything is measurable in monetary terms. It should be noted that increasingly environmentalists are monetarizing environmental costs as part of environmental policy making.

3.4.4. The Water Commissioner vs. Health Ministry

The Water Commissioner is interested in the development of wastewater treatment installations and widespread use of treated wastewater. For the sake of protecting wells and because of the existence of various types of ground contamination, the Health Ministry sets standards that the Water Commissioners considers to be too high.

3.4.5. The *Mekorot* Water Company vs. the Water Associations

Mekorot and the water associations compete over provision of water to various consumers. A local water association reduces the number of *Mekorot*'s clients.

3.4.6. The private sector vs. the government of Israel

The companies who deal with desalination of water have asked the Water Commissioner to make a commitment to purchase larger amounts of water and at higher prices, as an economic safety net. Even if the state does not need this water, the producers demand that state buy the high-priced desalinised water.

3.4.7. The Public Services Authority (Water and Sewage) vs. the water and sewage corporations

The role of the authority is to formulate criteria and prices for water and sewage services provided by the water corporations. In addition, its role is to supervise and monitor activities of corporations as far as services to the public are concerned. As a supervisory authority, there is a structured conflict between the Public Services Authority and the bodies it supervises, who are interested in as little supervision as possible, and want approval for prices to be as high as possible, with standards as low as possible. The Authority is still a fledgling body, and the number of water corporations that have been privatized is small, and therefore it is difficult to assess the degree of conflict.

3.4.8. Local Authorities vs. the government

Self-production is 50 percent cheaper than buying from the national water system. Because of the condition of the coastal aquifer, the Water Commissioner is drawing up a plan for rehabilitation of the aquifer. As a consequence of this plan it would be necessary to reduce pumping which is mostly carried out by the local authorities and this in turn would oblige them to purchase water from the *Mekorot* Company.

3.4.9. The Water Commissioner vs. the Ministry of Environment

There is a struggle between the Water Commissioner and the Environment Ministry, because there is an incompatibility between the bearers of authority, the areas of responsibility and management, especially on the subject of water quality.

Moreover, the ministries and entities that make and implement policy are themselves special interest groups, while other private and community interest groups also play an important role. All the issues discussed above - the multitude of bodies dealing with the subject, disregard for plans and recommendations, and non-implementation of decisions - are only part of the reasons for the failures in the process of laying down policy and policy making in the Israeli water sector.

State Comptroller Miriam Ben-Porath wrote in her special report on the administration of the water sector of 1990, she expressed criticism of the existing authorities

> For the purpose of regularizing the water sector, the responsibility for its administration should be transferred to a neutral, national, professional body, that will take into account the needs of the national economy, including those of the agricultural sector, and will ensure the quality of potable water for households,

and the supply of water in future in a regular and credible manner (*Knesset*, 2002:78).

Most of the witnesses, who appeared before the Knesset committee of Inquiry on the Israeli Water Sector in 2002 agreed that it was important that the water sector should be run by a professional body, with implementation capabilities. The Committee recommended that the possibility of turning the Water Commission into an independent and professional water authority, with a status similar to that of the Bank of Israel. In other words, the authority should be incorporated, and not subject to any Ministry, and its function should be to manage, regulate and direct the water sector, on the national and regional levels, in accordance with the instructions of the Water Authority Law that would be enacted, with the policy of the government and recommendations of the Water Council as reconstituted. The Authority would be headed by a professional in the sphere of water, who does not represent any particular interest in the water sector, and who would be appointed by the Government. This would probably decrease the multiplicity of ministries and other bodies regarding the water issues of Israel.

Chapter 4

Alternative Water Resources and its Economic Viability

As most conventional water resources are already developed or over exploited in Israel, there is a need to develop non-conventional options or alternative water resources to bridge water shortages. These options include brackish and sea water desalination, fresh water imports from outside the region either by sea or land, cloud seeding etc. Technically, non-conventional options are possible and feasible; however, these options are available at a high capital investment and are associated with some environmental and ecological impacts and political considerations. (Haddad, 2004:1).Non-conventional water options are widely encouraged in Israel and it is extensively utilized to overcome not only water shortages but also to restore economic growth, peace, and stability among regional parties and people.

Israel's main freshwater resources are the Lake Kinneret (or the Sea of Galilee), Coastal Aquifer (along the coastal plain of the Mediterranean Sea), and the Mountain Aquifer (under the central north-south (Carmel) mountain range). Additional smaller regional resources are located in the Upper Galilee, Western Galilee, Beit Shean Valley, Jordan Valley, the Dead Sea Rift, the Negev and the Arava. In 1959 a comprehensive water law was passed, making water resources a public property thereby regulating water resources exploitation and allocation, as well as pollution prevention and water conservation. Under the law, all available water resources are made available for use by consumers, as directed by the Water Commissioner.

The total average annual potential of renewable water amounts to about 1600 - 1,800 MCM (Arlozoroff, 1997), of which about 95 percent is already exploited and used for domestic consumption and irrigation. About 80 percent of the water potential is in the north of the country and only 20 percent in the south. According to the 1997 State Comptroller Report (p.283), the average annual potential of natural water during 1966 was around 1500 MCM. At present Israel's water potential is 2,220 MCM including 570

MCM in the Lake Kinneret, 1,199 MCM sweet and brackish ground water,135 MCM caught flood waters and 325 MCM reclaimed water (*Knesset*,2002:28)

On the utilization side, the demand for water shows continuous growth mainly because of influx of immigrants, urbanization, industrialization and constant rise in the standards of living. Report of State Comptroller for 1966 shows that more than 80 percent of Israel's natural water was being exploited and in 1964-65 it reached around 1230 MCM and to 1600 MCM in 1976(State Comptroller Report,1976). Israel, for example, reached its maximum utilization potential by the mid 1970s, when it consumed more than1600 MCM (Allan, 1996:39). Since then it has resorted to over-utilization of underground aquifers and non-replenishable resources that have led to salination and therefore deterioration of these important water resources (Zaslavsky, 1999:65). It should be pointed out that underground water accounts for over forty per cent of Israel's water supply.

The problem is gravest in Israel's largest aquifer, namely, the coastal aquifer sources. The costal aquifer is an underground reservoir extending from Mount Carmel in the north to the Gaza Strip in the south and from the shoreline in the west to the foothills in the east. Around one thousand seven hundred wells scattered throughout the coastal strip pump water from depths ranging from 50 to 150 metres and they account for about 450 MCM per annum. Deterioration of ground water quality is at its worst in the coastal plain, mainly due to densely packed sources of pollution. The two million residents of this region crowded into urban centres, many industrial zones and agricultural land cultivated intensively by modern methods create waste and pollutants which percolate from the surface into the ground water reservoir. The greater part of sewage in Israel is produced in the coastal plain and most of the farmlands irrigated with treated waste water are also located in this area. Thus the danger of waste water pollution is concentrated in this region more extensively than other interior regions. Over pumping during the past twenty five years has caused a drop in ground water levels and penetration of seawater from the west. Thus the aquifer's western edge became salinated to a distance of up to 4 kilometres from the shoreline and as a result many wells had to be shut down. (Sherman, 1999:22-25)

This aquifer parallels and is frequently located directly beneath Israel's heavily populated central zone where over-utilization causes ruinous seawater infiltration. However, it is also serious in the mountain aquifer. Paradoxically, Israel's sophisticated water system magnifies this deleterious impact. The aquifers most affected are those that make a major contribution to the overall system, partially because they are located in the middle of a water-carrier system that conveys water from the relatively more abundant north to the semi-arid southern area of Israel. Nearly 20 percent of the coastal aquifer cannot be utilized due to salinity (Sherman, 1999:22-25).

4.1. Policy Shift towards Alternative water sources

Israel's water policy underwent a major shift in 1997. Initial period of water policy established the emergence of policy paradigm of expansion of water resources and increase agricultural production. The agriculture sector consumes bulk of the water which amounted to around 64 percent in 2001 (Water commission Report, 2001:15). There were other development which demanded a shift; they include, large scale influx of immigrants during 1989-1994 which increased the population by almost 20 percent and peace treaty with Jordan in 1994 leading to increasing water quotas. The water policy hence, ceased to be an agricultural policy and new approach in management of shrinking water resources emerged. Consecutive dry winters during 1998 to 2000 led to a severe shortage of waters. Desalination became a preferred policy solution also as a result of drop in prices of desalination during the second half of the 1990's (Menahem, 2001:39).This new water policy explored options of desalination and importation of water from Turkey as alternative resources to meet escalating demands.

4.2. Demand and Supply of water in Israel

According to Israel's Water Commission Shimon Tal, "water supplies have reached their gravest crisis ever. Water reservoirs are empty and their level has gone beyond red lines." While discussing the need for non-conventional water resources which would be the main option for future demands, it is essential to analyse the sources.

On the supply side, the water from major three sources, namely, the Lake Kinneret, Coastal aquifer and Mountain aquifer, is not constant. For a variety of reasons the quantity as well as quality of water is decreasing and hence the supply of water is unpredictable and uncertain. Because of increasing population either by natural increase or through immigration, there is huge demand for water in domestic sector. The process of urbanization is getting momentum because of industrialization and hence the escalating demand for water in Israel. The agriculture sector, which is not growing but utilizing the lion's share of allocation is very strong and influences major policy options regarding water. Currently Israel utilises more than 95 percent of its freshwater balance and would need larger quantities in future. Countrywide consumption in 1994 amounted to almost 2,000 MCM. The difference between that consumption and the 1,700 MCM supplies from these three sources was covered by over-pumping of groundwater and use of treated effluent for irrigation. Over-pumping creates a deficit, which must eventually be replenished, and a series of dry years in the 1980s increased the deficit to a magnitude equal to a full year's consumption. Subsequent conservation efforts and aggressive recharging of aquifers have kept the problem in check.

Table.4.1. Capacities and Quality Ranges of Israel's Water Supply Sources

	Average annual replenishment and/or availability	**Range Quality**		
		TDS	**Chlorides**	**Hardness**
Source	**MCM/year**	**ppm**	**ppm**	**ppm as $CaCO_3$**
Lake Kinneret	470-600	450-650	180-250	200-245
Yarmuk River	25-70			
Mountain Aquifer	300-350	100-700	50-400	
Coastal Aquifer	240-300	200-1,200	100-700	50-750
Eastern Basin	250-350		25-2000	
Other water sources*	200		20-900	
Total natural water	1480-1870			250-350
Recycled wastewater	300-500	650-1500	170-500	250-350
Total all available water sources	1785-2370			

*Other aquifers and basins (Galilee, Carmel), floodwater, etc.

Source: Yosef Dreizin, Israel Desalination Society, 2006.

Lake Kinneret is the major supplier of natural water in Israel amounting to 600 MCM per year. Mountain aquifer accounts for the second largest supplier with less TDS (Total Dissolved Salt) compared to Lake Kinneret. Israel's average potable water supply quality is characterized by relatively high TDS and chloride concentrations and extreme hardness. The other major sources include the Coastal aquifer and Eastern Basin which supply 250-350 MCM of water per year. If one looks at the quality of water supplied from these basins and the content of total dissolved salts, Mountain aquifer supplies good quality of water compared to Lake Kinneret and Coastal aquifer (**Table.4.1**). Long-term monitoring by the Israel Hydrological Service indicates that the chloride, sodium and nitrate levels in the main groundwater supplying aquifers are increasing at alarming rates due to agricultural irrigation and recharge with higher Salinity Lake Kinneret water. These rates are expected to grow due to the increased usage of even higher salinity treated municipal wastewater (Dreizin, 1999:270).

On the consumption side, different sectors consume water in different quantities, with the agriculture sector consuming the larger quantity. Agriculture consumption increased in alarming rate during mid-1950s and continued till mid-1980s.Domestic sector consumed around 15 percent of water till mid-1970's and thereafter due to immigration pushed the demand further and in 2001 it consumed around 36 percent (**Table.2.7**).Industry sector consumed less quantity of water around three to four percent and it shows a gradual and slow increase in demand. Agriculture's consumption was robust but because of the major quota cut to the sector the fresh water consumption started decreasing. More treated water from effluent treatment plants and desalinated water from brackish water desalination plants were supplied for the agriculture demand. During 1958, out of the total 1274 MCM water available, 1032 MCM was consumed by agriculture sector. This trend followed because of the strong agriculture lobby in the water policy making. But after the Ministry of National infrastructure took over the control of water in 1996, the allocation of water to different sectors changed. Agriculture was given less quota because of depleting natural water resources and increasing population and the resultant urbanization.

If one looks at the demand side the situation is alarming. The total annual replenishable water accounts for only 1600 MCM, the demand is escalating to very high levels. The demand by different sectors during 2010 is expected to be around 2,500 MCM while the supply would be only around 1700- 2300 MCM. The gap needs to be covered by alternative water resources. The major sources for alternative water resources are desalination, including desalination of brackish water and seawater. Among different sectors, demand in the domestic sector is increasing at a fast rate while the agriculture sector and industry need lesser water. Though the largest share goes to agriculture sector, the increasing demand is seen in domestic sector (**Table.4.2**).

Table.4.2 Israel's Projected Water Demand by Water Quality and User Sectors (in MCM/year)

Year	2005	2010	2015	2020
Agricultural				
Potable water	530	530	530	530
Brackish water	160	140	140	140
Treated wastewater	300	500	600	700
Total	990	1170	1270	1370
Industrial				
Potable water	85	90	95	100
Brackish water	40	40	40	40
Treated wastewater	0	5	13	15
Total	125	135	148	155
Domestic				
Potable water	720	840	960	1080
Nature conservation	25	50	50	50
Aquifer Rehabilitation				
Potable water	100	200	0	0
Neighbouring entities	100	110	130	150
Total Demand	2060	2505	2558	2805

Source: Yosef Dreizin, Israel Desalination Society, 2006.

4.3. Need for alternative water resources

There is a need for alternative water resources because of the following reasons.

4.3.1. Sources of water and their problems

a. Lake Kinneret

Lake Kinneret, the Biblical Sea of Galilee, is the only large, natural fresh water Lake in Israel and it has been an important focus of human activity for thousands of years. With the creation of the State of Israel and modern day development of the country, Lake Kinneret has become the primary reservoir for Israel's National Water Carrier (NCW), an extensive surface and underground freshwater storage and supply. Lake Kinneret serves important functions in commercial fisheries, recreation and tourism. Human activity altered hydrology of the Lake at least since 1932. To conserve the Lake and its shores from flooding and to prevent over pumping, maximum and minimum water levels ("red lines") was defined by law during the British Mandate. The " upper red line was defined as minus 208.9 metres altitude and the "lower red line" as minus 212 metres altitude (Sherman, 1999:33).

Table 4.3 Level of water in Lake Kinneret and Average Salinity

WATER LEVEL AND AVERAGE SALINITY(Chloride Concentration)			
YEAR	WATER LEVEL In Metres Below Mean Sea Level		SALINITY(Chloride concentration in mg/lr)
-	May	November	
1926	..	-210.48	..
1930	-209.87	-210.52	..
1935	-209.07	-211.39	..
1940	-209.96	-211.46	..
1945	-209.31	-211.75	..
1950	-209.63	-210.83	..
1955	-210.18	-211.02	..
1960	-209.52	-210.27	363
(1)1965	-209.13	-210.17	352
1968	-208.87	-209.79	296
1969	-208.80	-209.39	254
1970	-208.78	-210.21	253
1971	-208.81	-209.89	238
1972	-208.94	-210.53	232
1973	-210.14	-211.56	239
1974	-209.45	-210.92	241
1975	-210.08	-211.70	239
1976	-209.82	-211.20	239
1977	-209.38	-210.59	231
1978	-208.89	-210.07	219
1979	-210.00	-211.66	225
1980	-208.84	-210.20	223

1981	-208.86	-210.14	217
1982	-209.63	-211.49	218
1983	-209.20	-210.60	213
1984	-209.32	-210.76	210
1985	-209.64	-211.47	212
1986	-211.06	-212.31	219
1987	-209.54	-210.74	213
1988	-208.80	-210.19	202
1989	-210.20	-212.29	208
1990	-211.25	-212.76	224
1991	-211.92	-212.79	239
1992	-208.80	-209.52	217
1993	-208.84	-209.72	208
1994	-209.12	-210.94	216
1995	-209.01	-210.85	215
1996	-209.60	-211.40	225
1997	-210.24	-212.01	230
1998	-210.46	-212.25	230
1999	-211.76	-213.00	243
2000	-211.92	-213.71	257
2001	-213.13	-214.78	272
2002	-213.18	-214.34	286
2003	-209.74	-210.93	254
2004	-208.92	-210.69	234
2005	-209.73	-211.64	236
2006	-210.68	-212.03	242

Source: The Hydrological Service of Israel, Statistical Abstract of Israel, 2007, Table.1.9

During 1948 to 1964 annual water level fluctuations in the Lake gradually reduced and the average annual water level was gradually raised to above minus 210 metres altitude. In 1964 Lake Kinneret became the primary storage and supply reservoir for the National Water Carrier (NWC).Starting with full operation of the NWC system in 1973, Lake Kinneret water level fluctuations again increased to greater than 3 metres.

With Israel's growing needs for water, combined with the capacity to pump water out of the Lake through the NWC, pressure was placed to allow the use of addition water and at the same time increase the storage capacity of the Lake. By 1981 the Israel water Commissioner shifted the lower red line by one metre, to minus 213 metre. Ten years later, in 1991 following a two-year drought, Lake Kinneret water level was reduced to its lowest level to minus 213 metres. A series of average and below average rainfall years from 1994 onwards, combined with increasing water requirements, led to the sequential reduction of the water level of Lake Kinneret from 1994 by about 0.75 each year, reaching the lowest ever value of minus 214.87 metres in November 2001. In August 2001 the Water Commissioner declared the new lower redline to be at minus 215.5 metres, the level below which water can no longer be pumped into the NWC. The last red line reduction to minus 215.5 metres has increased the storage capacity of the Lake by nearly 400 MCM. Over exploitation in one year inevitably leads to lower water levels in the following years.

As indicated by **Table 4.3**, water level shows major fluctuations throughout. During May the water level is higher compared to November because of the winter rains which is stored and utilized during summer. The water level which was minus 209 metres during the establishment of the state reduced further to minus 210 metres during 2006. The water level is further decreasing. Given the climate of the region, population growth and the potential for multi-national use of Lake Kinneret following regional peace (Syria and Jordan), there would be further reductions in water levels. Concern regarding the present suitability of the Lake's water for drinking purposes has led to calls for the establishment of even more stringent and costly filtration process to raise its quality to acceptable levels (Sherman,1999:16). Another major problem with the Lake Kinneret is the salinity. The chloride concentration range between 200 to 300 milligrams per litre and as highlighted by **Table.4.3** whenever there is fall in water level, chloride concentration increases mainly because of less addition of fresh water and more evaporation. In short, the Lake Kinneret's water level is decreasing and salinity is increasing. To increase the quantity of fresh water inflow, Israel use cloud seeding along the coast of the Lake which helps a marginal increase in inflow of fresh water.

b. The Coastal Aquifer

The Coastal Aquifer is one of the most important sources of groundwater in Israel. The Coastal Plain aquifer provides about 25 percent of its water supply and is considered its only long-term reservoir for bridging through spells of sequential dry years (Israel State

Comptroller, 1990). The North-South the Coastal Aquifer is 140 km long with an average width of 15 km and hence comprises a total area of some 1800 km^2. The aquifer is composed of Late Tertiary to Quaternary Sand and Sandstone with interesting layers of clay and fossil soils, which divides into a number of sub-aquifers (Issar,1968:21).The sandy deposits attain a thickness of about 120 metres near the coast, gradually becoming thinner towards the east. The basis of the aquifer is formed by a thick deposit of Tertiary days. Almost 80 per cent of Israel's population lives in coastal plain, which also includes a similar proportion of the country's economic activity. (Sherman, 1999:15)

Use of the Coastal Aquifer started at the beginning of the 20th century, supplying most of the water until the 1950s.The amount of wells gradually increased and so did the amount of water pumped from the aquifer, rising from 250 MCM in 1948 to 493 MCM in 1958. The opening of National Water Carrier in 1964 allowed a reduction in water withdrawals from the Coastal Aquifer. However, pumping later increased again, reaching 470 MCM in 1984-1985.Coastal Aquifers located beneath highly populated areas are often operated under stress management with an over of pumping leading to saltwater intrusion. Such over exploitation often results in saltwater encroachment into the coastal aquifer which can intrude hundreds of metres inland from the seashore. The continuous over pumping of the Coastal Aquifer has resulted in a drop of the water table, increased penetration of sea water and a general reduction in water quality. (Cabrera, 1999:308).The flow from the aquifer to the ocean was reduced and most of the irrigation water evaporated. Parts of the salts carrying water filtered to subsoil and the groundwater.

Several factors have further added salts and other pollutants to the coastal aquifer in the last several decades. One was irrigation over the aquifer with water from Lake Kinneret; the second was heavy use of fertilizers in agriculture that resulted in some chemicals, particularly nitrogen, leaking into the groundwater; the third source was salts seeping into the aquifer when extraction reduced water level, thus lowering the pressure that had kept salty water at bay; and the fourth source was urbanization with leaking sewage, oil and industrial pollutants. The average salt content of the Coastal Aquifer has reached 200 mg Clorine per litre and is rising. A number of wells are not operated anymore because of particularly high local concentration of pollutants. Treated effluents are significantly saltier than the brackish ground water because even after treatment, the water may be polluted with other undesired chemical and biological ingredients. The use of reclaimed water, depending on the degree of treatment, is therefore limited to insensitive crops. In addition, irrigation with recycled water above aquifers pollutes the underlying reservoirs rendering their water unsuitable for home use and in the long run, also for agriculture (Hambright, 2006:145).[1]

About 10 per cent of the coastal aquifer already exceeds the national limit for chloride salts and by 2010, if pumping continues, 20 per cent of the water would exceed the limit (Sherman, 1999:14).[2] The hydrological deficit of the Coastal Aquifer at the end of the 1980's was estimated at 1100 MCM (Scwartz, 1990:56).The extraordinary wet year 1991/92 replenished some of this deficit by adding a significantly high quantity of water to the system.[3] The average safe yield is about 283 MCM per year. However even less water is supposed to be withdrawn at the rate of 210 MCM per year to restore the aquifer. This will be further enhanced by artificial recharge with water from Lake Kinneret supplied through the National Water Carrier (Cabrera, 1999:308).

Table.4.4. Balance of ground water reserve in the coastal basin in MCM

Year	Natural Replenishment		Artificial Recharging	Pumping	Calculated Addition to Reserve
1996/97	240.84	111.75	407.57	407.57	+7.31
1997/98	242.00	126.06	420.08	420.08	0
1998/99	111.72	109.94	505.36	505.36	-- 208.06
1999/00	219.53	127.98	542.36	542.36	-- 113.50
2000/01	209.50	110.00	474.00	474.00	-- 100

[1] For details also refer Yoav Kislev (2006), "The Water Economy of Israel", in Ed. Water in the Middle East; Co-operation and Technological Solutions in the Jordan Valley, by K David Hambright, F Jamil Ragep and Joseph Ginat, Sussex Academic Press, Portland.
[2] For details also refer to Nurit (1994), "Water Resources and Conflict in the Middle East", New York, Routledge.
[3] Rainfall exceeded the normal by 200% during 1991/92

Source: The Ministry for National Infrastructure - The Water Commission, the Hydrological Service, 2002.

The balance of ground water reserve by natural replenishment is showing a decreasing trend. During 1996-97 it was around 240 MCM and 2000-2001 it reduced to 209 MCM. Artificial recharge is also fluctuating during this period; as against 111 MCM in 1996-97 it went up to 127 MCM in 1999-2000 but a decreased to 110 MCM the following year. But the pumping of water from this increased steadily and it reached peak during 1999-2000 to 542 MCM (**Table.4.4**). According to the most recent report of the Hydrological Service, about 15 percent of the total amount of water pumped from the Coastal Aquifer does not comply with existing drinking water standards for chloride and nitrate concentrations.

In the 1930s, before intensive exploitation of the Coastal Aquifer began, this aquifer's water was characterized by low salinity ranging between 50-100 mg/litre and insignificant pollution of less than 10 mg/litre of nitrates. Over pumping where pumping exceeding the replenishment rate subsequently reduced water levels by 6-10 metres and changed water flow directions. This disturbed the delicate balance between the entrance and exit of salts and pollutants and resulted in continuous increases in chloride concentrations Average chloride concentrations in the coastal aquifer are continuing to increase at an average rate of two mg/litre per year, reaching an average of 195 mg/litre in 2002/03. Chloride concentrations below 250 mg/litre and nitrate concentrations under 45 mg/l exist in only 50 percent of the water which is drawn from wells in the coastal basin. These concentrations are unsuitable for unrestricted agricultural irrigation.

Likewise, the nitrate concentrations in the Coastal Aquifer have increased considerably due to intensive use of fertilizers in agriculture and use of treated effluents for irrigation. Since 1950, average nitrate concentrations have increased from 30 mg/litre to 63 mg/litre at present, with an annual rate of increase of about 0.6 mg/litre. Concentrations exceeding 70 mg/litre were measured in traditional agricultural areas in the centre of the country. In more than half of the wells, the nitrate concentration is higher than the European drinking water standard (50 mg/l) and in more than 20 percent of the wells; it is more than the Israeli standard of 90mg/l (Feinerman, 1999:43).

Some legislative measures have been taken to regulate the amount of contaminants. The Water Law of 1959 is the principal law regulating the flow of pollutants into the country's water ways. It was amended in 1971 and again in 1991; the former to include prohibitions against direct or indirect water pollution and the latter to facilitate more effective enforcement through stiffer fines and obligatory clean up measures. More recently the Ministry of the Environment has prepared regulations on effluent irrigation, limiting nitrate concentrations in irrigation of areas overlying the northern and central parts of the coastal aquifer. Other measures include additional installations for artificial recharge and to supply existing consumers with alternative water resources (Cabrera, 1999:309).

Table. 4.5 Average Salinity (Chloride concentration) in milligram/litre of Coastal Aquifer (1958-2006)

Year	Average Salinity (Chloride concentration) in mg/lr	
	Mountain Aquifer	Coastal Aquifer
1958	146	112
1960	164	112
1965	143	117
1967	149	121
1968	162	122
1969	151	124
1970	159	130
1971	149	132
1972	159	132
1973	148	130
1974	151	135
1975	161	135
1976	156	137
1977	163	142
1978	153	144
1979	135	146
1980	141	149
1981	143	150
1982	157	154
1983	155	157
1984	148	160

1985	146	166
1986	137	162
1987	133	166
1988	147	168
1989	140	171
1990	159	173
1991	138	174
1992	150	179
1993	146	181
1994	145	185
1995	143	191
1996	141	188
1997	142	190
1998	139	192
1999	149	193
2000	139	194
2001	133	198
2002	136	197
2003	136	195
2004	130	198
2005	139	198
2006	136	207

Source: The Hydrological Service of Israel for several years, Statistical Abstract of Israel, 2007, Table.1.8.

If one examines the average salinity of coastal aquifer, it shows a gradual increase in chloride concentration from 1958 when it was around 112 mg/litre and without any decrease it gradually increased to 207 mg/litre in 2006, this is almost double the quantity when documentation of the salinity began (**Table.4.5**). This is mainly due to water in this region being used mainly for irrigation. The increase in salinity is attributed to over pumping of water, pollution by urbanization and intrusion of seawater. There is practically no recharge from the limestone aquifers lying towards the east. This is due to a thick layer of impermeable rocks, which separates between the limestone and the sandstones. In the southern half of the Coastal Plain its sandstone layers are in contact with semi-permeable chalk layers of Neogene and Palaeogene age. In these areas there exists an infiltration of saline water, which contains brackish water. This causes the water in the south-eastern part of this aquifer to become brackish (400 to 800 mg/l Cl) and in some area to contain high levels of natural nitrates (30 to 70 mg/l). As the Coastal Plain becomes one of the most densely populated areas in the world, further pollution cannot be avoided. Moreover, the rapid urbanization of this region causes wider parts of it to be covered by impermeable concrete and asphalt, which reduces the natural recharge to this aquifer. At the same time, continued pumping has reduced to a minimum the quantities flowing to the sea while constantly increasing the salinity in the aquifer. Thus salinity still threatens the Coastal Aquifer from all directions.

c. Mountain Aquifer

The Mountain Aquifer is a source of high-grade fresh water for the Israeli metropolis in which the quality of water is far superior to the Coastal Aquifer. (Sherman, 1999: 17). It functions as a seasonal and international buffer, in conjunction with Lake Kinneret and the National Water Carrier system, to ensure water supply. The amount of storage in the aquifer between the uppermost level ,in which the water escapes through natural springs, and the lowest or red line amounts to about 900 MCM. The Mountain Aquifer is built of permeable limestone (The Judea Group of Turonian-Cenomanian age).This aquifer is composed of hard calcareous rocks of Cenomanian-Turonian age, which crop out in the central mountain ridge of the country. Its main reserve is situated in the Yarkon-Tanninim basin east of the Coastal plain, extending South to the city of Be'er Sheba. The aquifer is of a Karstic nature with high conductivity and swift flows. The Mountain Aquifer, extending eastward of the Coastal Aquifer, from the slopes of Mount Carmel to Be'er Sheba and from the crests of mountain ridges to the coastal plain, serves as the principal reservoir of drinking water in the country. It supplies drinking water to Dan region, Tel Aviv, Jerusalem and Be'er Sheba. Presently it is the most important long-term source in the national water system due to the serious condition of the Coastal Aquifer, both with regard to quality and quantity and is intended to store excess winter flood waters from the Lake Kinneret. (State Comptroller Report, 1990:17)

Pumping operations sited on the western slopes of the Judean hills and uncontrolled flows of sewage of effluent of industrial waste are liable to result in serious depletion, salination and pollution of Mountain Aquifer. The dangers of salting and pollution in the

Mountain Aquifer are aggravated by its karstic limestone or dolemete structure (Sherman, 1999:21).[4] In contrast to the sandy Coastal Aquifer, in which the subterranean movement of liquids is slower and more regular, in the Mountain Aquifer where flows occur in underground rock fissures, cracks and crevices, movement is likely to be far rapid, irregular and unpredictable. Thus the inflow of intrusive saline water or pollutants into pumping sites is also likely to occur in rapid irregular and unpredictable fashion as over extraction lowers the water table levels.

Use of the Yarkon-Tanninim aquifer increased rapidly since the 1950s, reaching annual withdrawal levels to more than 400 MCM. These figures are higher than the long-term safe yields estimated at 310 MCM per year. Due to the high permeability of this aquifer its storage capacity is low. These cause the water table to rise sharply during wet years. Thus after the humid years of 1991-1993 the Yarkon springs renewed their flow. Since then the water table have fallen by 4.5 metres.[5] Water levels in the aquifer dropped by more than eight metres during 1970-1990, passing the so called red line in 1986 and 1990, when water quality deteriorated due to pollution. Every meter in the level of the aquifer represents an estimated amount of 100 MCM water. Lowering of the water level in the aquifer beyond the red line may introduce salinity problems in this largest groundwater reservoir of the country. The extraordinary rainy season 1991/92, the wettest year since recordings began in Jerusalem in 1846, resulted in considerable recharge of the aquifer (Cabrera, 1999:309).

The salinity of the springs along the eastern coast of the Dead Sea gets their salts, most probably, from the contact with the interface of the Dead Sea water. Thus fresh water may be tapped more to the east, nearer to the ground water divide. This means deep wells and pumping from great depth, which implies non-conventional methods of drilling and pumping. Preservation of its quality is of great importance. Thus salinity and decreasing water level pose a major problem to water supply.

4.3.2. Population Increase

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[4] Also refer Grinwald, (1989), "Water in Israel 1962-1989", Tel Aviv; Water Allocation Department, Israel Water Commission.

[5] Hydrological Survey of Israel for several years.

Since its establishment the State of Israel has expressed its deep connection to immigration. The declaration of independence states: "The State of Israel shall be open to Jewish immigration and to the ingathering of the exiles." This guided its immigration policy and was enshrined in the Law of Return, which categorically declared that 'every Jew has the right to immigrate to Israel." The mass immigration in the first decade of its existence (about one million people arrived in this period) doubled Israel's population, and had a dramatic impact on water composition. During the 1960s, immigrants continued to arrive from many different countries. Particularly prominent over the last 30 years has been the large number of immigrants from the Soviet Union since the late 1980s (Hacohen, 2002:177).

Table.4.6. Population of Israel and the Available Water

WATER SOURCES in MCM							
Year	**Israel Population (million)**	**Fresh water**	**Reclaimed**	**Desalination**	**Brackish water**	**Required supplement**	**TOTAL Utilized Supply**
1999	6.219	1467	278	0	166	170	1915
2002	6.498	1467	298	0	166	35	1966
2005	6.789	1467	403	355	166	26	2417
2010	7.300	1467	509	500	140	- 75	2541

Source: The Ministry for National Infrastructure- The Water Commission, the Hydrological Service.2002.

As **Table.4.6** indicates, the population of Israel has been increasing but the water available through the natural sources remains constant at 1,467 MCM. The utilization is very high than the actual availability and this gap is filled by the alternate water sources like desalination, reclamation of sewage water, treatment of brackish water etc. The required supplement has decreased from 166 MCM in 1999 to 26 MCM in 2005 and would reach Minus 75 MCM for 2010. This is mainly because of the contribution from the desalination projects that is carried over during the recent years. Large number of desalination plants is being constructed along coastal areas to supplement the growing demand of water in Israel.

Table.4.7. Per Capita Water Consumption in the Domestic and Municipal Sector

Year	Population(Thousands)	Water Consumption(MCM)	Per Capita Consumption(m^3)
1990	4821.7	554.8	115.1
1992	5195.9	490.1	94.30
1994	5471.5	555.5	101.5
1995	5612.3	588.2	104.8
1996	5757.9	604.0	104.9
1997	5900.0	621.2	105.3
1998	6041.4	671.7	111.2
1999	6209.1	681.8	109.8
2000	6369.3	662.1	104.0
2001	6508.8	658.4	101.2

Source: The Ministry for National Infrastructure- The Water Commission, the Hydrological Service.2002.

The per capita water consumption in the domestic and municipal sectors throws light on the water requirement of the Israel. Though the consumption shows a marginal difference, the increase in population has to be considered for the increase in demand of water and thus the overall increase in total quantity required. During 1990 the per capita consumption of water was 115 m^3 for a population of 4.821 million and during 2001, the per capita consumption was 101 m^3 for a population of 6.508 million and hence a decrease in the total consumption of water. This is because of less availability of fresh water. During 1990 the availability of fresh water was high and in subsequent years because of over consumption and decrease in quality of water and increase in population the per capita availability decreased (**Table.4.7**).

4.3.3. Urbanisation

Israel is undergoing rapid urbanization with increasing population living in urban areas. The provision of water supply, sanitation and drainage are key elements of urbanization process. Sanitation and drainage arrangements are fundamental while considering the urban hydrological cycle. Urbanisation causes radical changes in the frequency and rate of subsurface infiltration. This reflects seriously in quality deterioration influencing the groundwater level and quality as well as the flow regimes in underlying aquifers. The major impact of urbanization on groundwater is the perturbations of hydrological cycle, quality deterioration within the urban limit and uncontrolled aquifer exploitation (Foster, Lawrence and Morris, 1996:106).

Almost 80 per cent of Israel's population lives in coastal plain, which also includes a similar proportion of the country's economic activity. It would thus seem natural that this littoral metropolis should expand eastwards to avoid congestion and the ecological, transportation and other environmental hazards which are liable to result from cramming additional population in to a narrow strip 100km long and 20 km wide along the seafront. The construction of Jewish settlement in the West Bank occupied by Israel following the June 1967 war has been controversial and was branded as illegal and obstacle to peace by the international community. Hence because of international pressures (as in case of the Likud-led coalition in 1977-92) or because of purposeful policy preferences (as in case of the Labour-led coalition in 1992-1996), Israel adopted a building policy which avoided extensive eastward expansion of the urban seaboard.[6]

The result has been a huge concentration of construction in the coastal region which aggravates the water situation in two important ways. Firstly, such a policy inevitably results in a reduction of the water absorption or recharge capacity of the aquifer. Increased coverage of the surface rain falls into the substrata and increases run-off losses via greater water flow directly into the sea. Secondly, it increases volume and intensity of human activity above the aquifer which in also increase the risk of greater pollution of the existing ground water stocks. (Sherman, 1999:16)

Urban development above the aquifer can reduce substantially the amount of water that infiltrates and recharges the water resources. Out of the 1900 km^2 coastal plain, about, 650 km^2 are already urban, and another 625 km^2 are expected to become urban by 2020

[6] At one time, for example, Israel was hoping to settle more than a million Israelis in the occupied West Bank through extensive construction of Jewish settlements. Despite political and ideological considerations and economic incentives, the settlement population in the occupied territories remains at about 400,000, including nearly half of that population that lives in post-1967 borders of East Jerusalem.

(Bryan, 1999:409). The coastal aquifer is Israel's largest reservoir, the only one that provides multi-year storage. It is a phreatic aquifer under the coastal plain, with a strip 10-30 km wide and about 130 km long, with a thickness ranging between 200 metres close to the coast and tapers out at the eastern end. Average rainfall ranges over the area from 300 mm in the south to 700 mm in the north, with an area average of about 500 mm. For many years pumping has exceeded recharge, causing a drop in water levels and seawater intrusion. Though more recently, pumping was reduced quite substantially, it has still not reached the long term equilibrium value (Bryan, 1999: 409).

Much of Israel's urban development has taken place in the coastal plain by 1990, some 650 km^2 had already been built, of which 250 km^2 are impervious. It is expected that the urban area will practically double by 2020, to an estimated 1275 km^2, with 500 km^2 impervious area. Urban expansion is driven by economic and population pressures and it is dictated by considerations for protecting groundwater. If the current development trend continue, between 1990 and 2020, the percentage of open space would be reduced from 65 percent to 33 percent of the 1900 km^2 (within the developed areas there are some open spaces, but each is small, less than 3 ha), and the impervious area will increase from 240 km^2 to 500 km^2(Bryan, 1999:411). The housing area would be doubled to 330 km^2 by 2020 from 160 km^2 in 1990 mainly due to the construction for the immigrants. The area under cultivated agricultural land would show a major reduction by 2020 from 930 km^2 to 360 km^2, which depicts the intensification of agriculture and adoption of new technologies like greenhouse crops which requires comparatively small area. Thus the increase in impervious area would reduce the open space available for the rain water or any surface water to percolate and get added to the groundwater system or the aquifers (**Table.4.8**).

Another, important is the water provisions in the Israeli-Jordanian peace treaty of 1994. The conflict heightened after the 1967 war, when Israel took exclusive control of the Jordan River by occupying the Golan Heights and deviating the Jordan waters from the Sea of Galilee through the National Water Carrier into the Negev. During the peace negotiations in the early 1990s, it was primarily the Jordanian side that pressured for an inclusion of the water issue in the agenda. After fierce resistance, this proposition was ultimately accepted by Israel, and Article 6 of the Peace Treaty exclusively deals with water issues (water allocations are specified in Annex II of the treaty)

The peace treaty, and the water regulations included in it, is probably still too recent to come up with an assessment of their solidity. However, it must be underlined that the tensions over water that arose after the signing of the treaty were all settled in a peaceful, cooperative manner.[7] The Israeli-Jordanian accord has one significant element that we have to retain: through the establishment of a cooperative solution, the total amounts of water supply increased. On 28 September 1995, Israel and the Palestine Liberation Organisation (PLO) signed the "Interim Agreement on the West Bank and the Gaza Strip" (also called Oslo II). Annex III of the agreed treaty covers, among other issues, the interim solution of the water conflict between the two parties. The disputed water resources are to be found primarily in the Mountainous Aquifer. Since the occupation of the West Bank in 1967, Israel strongly limited the Palestinians' access to these groundwater resources. In the Interim Agreement of 1995, Israel and the PLO agreed that the Palestinian population should receive an additional portion of 28.6 MCM per year of the disputed waters during the interim period. Still, Israel only made the commitment to deliver an additional 9 MCM per year to the Palestinian cities, while most of the additional water was to be developed by the Palestinian Authority (PA), and it was not specified from which sources this increase in water supply should come. Compared to the previous situation of unilateral occupation, the agreement was an important turning point towards a contractual solution between partners having an equal right of existence and self-determination that explicitly included the access to water (Stucki, 2005:47).This peace agreements and interim agreements where water sharing with neighbouring countries would also decrease the actual availability of water. The local demand of water is increasing as well the supply to neighbouring countries also is increasing which eventually pose problem to the water sector in Israel.

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[7]Also refer to Haddadin, Munther(2002), "*Diplomacy on the Jordan: International Conflict and Negotiated Resolution*" ,Dordrecht: Kluwer Academic Publishers, 418-26.

4.4. Alternative water sources

The marginal water sources are composed primarily of brackish water, seawater, and urban waste water. The potential contribution of marginal waters to meet the anticipated water demand includes the following alternatives: desalination of seawater, desalination of brackish waters, treatment of sewage water and import of water. In addition to this two more sources are possible which are economically less viable namely, seed clouding and catchments of flood waters

4.4.1. Desalination

Desalination means the removal of fresh water from saline water. Many methods have been proposed for desalting saline water, but few were commercially used. The two most popular methods for classifying the well-known desalination processes are processes in which desalination taking place involves phased change. The three main methods includes

a. Multi effect (ME) distillation

b. Multistage flash (MSF) distillation

c. Vapour compression (VC) distillation.

The other processes in which desalination takes place without any phase change are

a. Reverse osmosis (RO)

b. Electro dialysis (ED) (Alaa' Abdulrazaq Jassim and Saleh Ismail,1999)

The multi-stage flash (MSF) procedure is the most common technique for desalination, found mostly in the Persian Gulf (Awerbuch, 1997b). Globally this techniques adds up to about 48 percent of the total number of bigger plants with a capacity of over 4,000 m^3/day. Among other evaporation techniques, the multi-effect distillation (MED) may be mentioned here, either with vertical or horizontal smooth tubes or doubly fluted tubes. The vapour compression course is very popular for remote locations, resort areas, islands, etc. These two techniques, though not widely used, are promising as far as good water quality, simple application, reliability and efficiency are concerned. Membrane processes, mainly reverse osmosis (RO), are currently the fastest-growing techniques in water desalination. Other types of membranes, described below, are used for water quality improvement (Semiat, 2000:54). The RO membrane technique is considered the most promising for brackish and seawater desalination and most of the desalination plants in Israel use this technique.

The year of 1962 marks the start of seawater desalination in Israel, as it was decided to construct a Multi-Stage flash distillation plant with a capacity of 3800 m^3/day in Eilat, along the Red sea in the southernmost part of Israel. The actual supply of desalinated seawater began in 1965. *Mekorot* has been active in the field of desalination for the last four decades (**Table 4.8**). At the beginning, the activity was focused on water supply in remote regions like Eilat, Arava and the Dead- Sea which the national water grid did not reach. More recently the activity has expanded to other regions to enhance the depleted water grid and/or to reduce salt content in the coastal aquifer. All the projects were defined and approved in three consecutive master-plans. The fourth master-plan, operative since the beginning of 2005 until 2010, includes two BWRO and secondary effluents desalination plants and two SWRO plants: one in Eilat and one in Ashdod.

Table: 4.8 The main milestones of *Mekorot* desalination activity:

1965	Start-up of First Multi Stage Flash (MSF) Desalination Plant, combined with Eilat Power Station
1971	Redesign and Erection of a Second MSF Unit in Eilat
1972	Start-up of First BWRO Pilot Plant in Eilat
1973	Start-up of First Multi Effect Distillation (MED) Plant in Eilat; First BWRO Small Scale Plant Start-up
1977	First SWRO Pilot Unit (Eilat, Red Sea)
1978	First Large Commercial BWRO Unit (Sabha A - Eilat)
1979 - 1990	Continuous Extension of BWRO (Sabha A) in Eilat and Additional BWRO Units in Arava Region
1991	First SWRO Pilot Plants (Ashdod- Mediterranean Sea); Conceptual Design of a 24,000 m3 /day SWRO Using SW/BWRO Brine Mixture.
1992	Design and Erection of a Second BWRO Plant in Eilat (Sabha B) Winning Bidder of International tender released by the Water Commissioner
1995	General Design and Tender Promulgation of 3×8,000 m^3 / day SWRO in Eilat (Sabha C)
1996	General Design of SW Desalination Plants (10 M m^3 /year) in Western Galilee.

1997	Start-up of First Commercial SWRO Plant in Israel (Sabha C-8000 m^3/ day)
1998	Retrofitting of Sabha C to 10,000 m^3 /day; First UF Pilot Unit as Pre-treatment for Polluted BW Desalination in the Framework of Multi-national Research Program support by the EU
1999	General Design and Tender Preparation of Second Desalination Unit in Sabha C; General Design of SW Desalination Plant in Ashkelon(30 and 40 MCM /year)

Source: Yosef Dreizin, Israel Water Commission, 2006.

The Ashkelon Desalination plant is the largest operating Sea Water Reverse Osmosis (SWRO) desalination plant in the world. It reached its 50 percent capacity on August 2005 and 100 percent capacity by December that year. Until August 2006 it has produced approximately 91 MCM, while its expected cumulative production is more than 130 MCM of high quality drinking water by December 2006. It has achieved a daily production of 348,000m^3/day and has an expansion capacity for additional 10-15 percent. The plant produces water of excellent quality in accordance with tough requirements stipulated by the Israeli Water Desalination Administration (WDA). Since the inception of production, no water was rejected on water quality related parameters. With the desalination process in Israel, the future water demands are to be met by the various desalination techniques. The quantity of water produced during 2005 through desalination amounts to 100 MCM , and in future its demand is estimated to be 315 MCM for 2010, 500 MCM for 2015 and 650 MCM for 2020 (**Table.4.9**). This increasing demand of desalinated water is achieved by large-scale seawater desalination process.

Table.4.9 Seawater Desalination within Israel's Projected sources of Water Supply

Year	2005	2010	2015	2020
Potable water				
Natural sources	1470	1470	1470	1470
Desalinated brackish water	30	50	80	80
Desalinated seawater	100	315	500	650
Subtotal	1600	1835	2050	2200
Brackish water	160	140	140	140
Treated wastewater	300	450	520	600
Total	2140	2425	2710	2910

Source: Yosef Dreizin, Israel Water Commission, 2006.

Larger capacity designs recently prepared for desalination plants were erected at southern Mediterranean sites. Two types of raw water were considered: cooling water from central power station at elevated temperatures, and open surface seawater, directly from existing intakes. These designs are based mainly on the experience gained during the design and operation of the SWRO plant in Eilat, and on the comprehensive pilot testing of RO and UF technologies operating with relative low quality seawater (power-plant seawater from intake and outfall). Advanced pre-treatment methods, using UF membranes were compared with conventional media filtration. Based on field testing, on preliminary cost quotations from UF systems suppliers and overall system optimization, advanced pre-treatment show an economic edge of more than 10 percent or more if high quality permeate is required. So desalination of seawater gains momentum in Israeli water sector in the recent years and would meet out the increasing demand of water in future also.

Furthermore, Israel, as many other countries worldwide, started with seawater desalination before desalination of brackish water. However, in the early 1970s, *Mekorot* initiated a comprehensive field testing program followed by implementation of brackish water desalination at remote locations lacking potable water. In 1978, it started gradual replacement of the seawater desalination capacity in Eilat, by brackish water desalination, using various RO membrane technologies. In 1982, the total 11,000 m^3/d of seawater capacity was fully replaced, thus achieving a very large saving in energy (over 20,000 tons of fuel-oil per year). Currently, *Mekorot* operates more than 30 BWRO units with a combined capacity of more than 40,000 m^3/d. The ongoing brackish water desalination projects will double this capacity in the next three-five years (Glueckstern and Priel, 2006:1).

Most of the existing desalination capacity is located in the southern part of Israel, more than 90 percent at the Eilat-Sabha desalination centre. The existing BWRO units include three different plant types:

- Large 5,000 - 10,000 m3/d units fed by 15-20 brackish water (5,000 - 7,000 ppm TDS) wells, located up to 20 kilometres from the desalination site (Eilat-Sabha).
- Medium size (1,200 m^3/d) units fed by a single brackish water (2,500 ppm TDS) well.

- Small size (20 - 500 m^3/d) units used for water quality improvement at remote locations, where general water supply, except for drinking and cooking, use low quality sources of up to 2,500 ppm TDS.

Hydro-geological surveys have revealed that the Negev and the Arava valley possess considerable reserves of saline underground water with a variable concentration of salts. Many studies have been carried out to investigate whether this water can be used for irrigation. It was found that certain crops, such as cotton, tomato and melon, readily tolerate saline water (up to 7-8 dS/m electric conductivity, equivalent to salinity of 0.41-0.47 percent NaCl). For certain crops, there is no doubt that saline water can be used for irrigation in place of fresh water. However, to minimize accumulation of salts around plant roots and facilitate leaching away of salts that do accumulate, it is essential to use drip delivery systems and to cultivate the plants in soil-less medium or light soils (sandy or loamy-sandy soil).

The Eilat- Sabha BWRO centre is composed of two plants - Sabha A and Sabha B - with a combined capacity of about 38,000 m^3/d. The two plants are located near the tourist town Eilat, and supply about 70 percent of the town water consumption. The first phase, consisting of one unit with a capacity of 700 m^3/d, was completed in March 1978. This plant was extended and retrofitted in several phases. Following the last development phase, completed in 1999, Sabha A consists of five units with a combined capacity of about 28,000 m^3/d. In July 1993 an additional BWRO plant (Sabha B) was put into operation. This plant started with an initial capacity of 6,300 m^3/d and was extended in April 1996 to a capacity of 10,000 m^3/d.

4.4.2. Recycling of sewage water

Increasing quantities of sewage water have been finding their way into the environment and endangering groundwater and other sources of fresh water. Brackish water is used for irrigation of salinity-tolerant crops like cotton. In several crops, such as tomatoes and melons, brackish water improves produce quality although lower yields are achieved. The use of reclaimed water for irrigation of edible crops requires a high level of purification. For that purpose, a unique technology called as Soil Aquifer Treatment (SAT) is now being applied in the densely populated Dan region at the Shafdan plant, a large-scale project for processing sewage to produce purified water. The process allows the same water to be used twice. The treated water is recharged to a nearby aquifer. Two major benefits result aroused out of this are percolation of the water through the soil layers provides an additional cleaning phase, and the aquifer serves as an underground reservoir for the recharged water, preventing loss by evaporation. Water is pumped off when needed, mainly in summer. About 100 MCM of this purified water is transported annually via a separate pipeline called the "Third Negev Pipeline" to the western Negev for irrigation. Due to the high degree of purity of the treated water, it can be used for all crops without any health risk. Additional plants for processing sewage water for irrigation are under construction or on the planning boards. Most of the water allocated for agriculture eventually consists of purified effluents.

Smaller-scale plants in the Negev provide treated sewage water for irrigation of fields located a short distance from the source of the effluent. This water is of inferior quality because of minimal treatment, and use is restricted to irrigation of crops such as cotton in the summer. Small projects of this type are reported to be highly cost-effective. While the benefits of recycling treated sewage water are indisputable, contributing to the water reserves by providing a substitute for the use of fresh water in agriculture and reducing pollution, there is one drawback which must be considered is the domestic and industrial effluents which are saltier than the fresh water supplied (due to detergents and salt in dishwashers and salt and other chemicals used by industry). As a result, the concentration in salts in recycled water is about twice that in fresh water, and irrigation with recycled water causes a gradual salination of the soil. The problem of soil salination can be overcome by regularly monitoring salt concentrations and by flushing out accumulating salts downwards from the soil layer where the roots are active. The option of desalinating treated effluents needs to be given serious consideration in the future.

4.4.3. Water import

Water import is one of the solutions to meet the growing water shortage in Israel. Importing water is possible through pipes, where water is carried in pipes from the country where water is available in plenty to the destination where water demand is predominant. But construction of pipeline and maintenance is of great importance, since the pipe has to cross the physical boundary of one country to other. Given the prevailing Arab-Israeli conflict, security has to be taken care of. Apart from this the maintenance cost and protecting pipes from attack and leakage is considerably important. Another way of importing water is through tankers carried by ships through sea. This is also an economic way of importing water where water is carried in specially built tankers. There was another way to import water through plastic bags which are tied to tug boats and carried in the sea.

There were proposals to carry Nile water to the Sinai desert and from there to the Gaza Strip and Israel. Following the signing of the peace agreement between Egypt and Israel in 1979, leaders of the two states considered the proposal. Subsequently, several specialists tried to translate it in to an economic plan (Ben-Shachar et al, 1989: 76). Before any progress could be made, an opposition to the idea was voiced by Ethiopia which argued that before the Nile water was removed to a different drainage basin its rights had to be considered. In Egypt, too, objections were raised to the transfer of Nile water to the Jewish state. In Israel there were some who argued that Israel must not be dependent on Egypt in respect of such an important resource, while others gave the pollution of Nile water as a reason not to bring it to Israel (Sofer,1999: 237).

The main focus of Israel in the 1980s was to import water from southern Turkey .Dozens of rivers flow from the Taurus Mountains and empty in to the sea, and Turkey does not utilize their water owing to topographical factors. Former Yugoslavia, Italy and France also have abundant water close to their coast lines, but they are farther from Israel. The idea is to transport water from Manavgat River in Turkey which has a large discharge of water that flows in the direction opposite to Cyprus. The excess water from this river is to be transported to an Israeli port in special containers. These containers, known as "Jellyfish", are 1968 feet long and made out of a plastic material with double walls. Each container can carry about two MCM of water when it is sunk in the sea and is towed by a tug boat (Libiszewski, 1995:56-57). Another idea is a floating "water snake", which is comparatively less costly than the "jellyfish" (Sofer, 1999:241). Israel has planned to buy 50 MCM of water annually from Turkey for the next twenty years. Turkish water would satisfy less than five percent of Israel's water needs, but would be used for emergencies such as droughts. Officials of both countries agree that the accord is not solely about water supply but about strengthening relations between the two countries, and setting an example of economic interdependency in West Asia. The idea of exporting Turkish water from the Manavgat River to Israel appeared on the radar screen when Israeli Prime Minister Ehud Barak visited Turkey in 1999, a time when Israel was in the midst of a serious drought.

Since then, Turkey has finished a $150 million anchorage and a pumping station and treatment plant at the estuary of the Manavgat. That estuary, near Antalya on the Turkish Mediterranean coast, is approximately 325 nautical miles from Israel's Ashkelon port, to which the water would be shipped. The Manavgat River has facilities capable of exporting 180 MCM of water using tankers. This means that at 50 MCM of water per year, Israel would purchase only a portion of the river's annual water supply. Turkey hopes that the Manavgat River project would eventually supply water to other eastern Mediterranean countries suffering from water shortages, including Syria, Jordan, and Greece. So far, however, there is no other customer for Turkish water other than Israel. As a result, Turkey's expectations from Israel regarding previous trading commitments have intensified. On 23 July 1999, *The Jerusalem Post* reported that Turkey "threatened to call off military deals with Israel if the water deal was not signed, and at one time there was even concern in Jerusalem that Israeli firms would be frozen out of lucrative tenders in a massive development program in south-eastern Turkey if the water deal was not finalized."

Importing water raises several difficulties, economic and geopolitical. To reduce the cost of the water and its transportation, a suitable terminal must be built at the port of exit, which will include water containers and pumps to transfer water from the river to the containers or directly in to the jellyfish. In addition, a special port or installation for docking the tugboat and its containers must be built in both the exporting and importing countries and in the latter a system to direct the water from the containers to the national water system. A fleet of tugboats and jellyfish is necessary for transporting the water. According to an initial estimate, [8] an investment of about $200 million would be necessary; about $50 million for a terminal in the exporting country, about $100 million

[8] Report given by Israeli Water Commissioner Dan Zaslavsky , 6 July 1990.

for a terminal in the importing country and about $50million for the fleet. The hypothetical cost per cubic meter for imported water is $0.22-0.25 .Others believe that the price could be as high as $0.75 (Pope, 1990: 48; and Allan, 1994: 77).

4.4.4. Cloud Seeding

Cloud seeding is a method of increasing the cloud extractable water and has been used in Israel since 1960. Its effects on precipitation are still controversial. Increase in precipitation does not necessarily result in more runoff, which is critical to water supply. From 1961 to 1975, two scientifically designed cloud seeding experiments were carried out in the northern and central Israel using a two-target crossover design. The first experiment claimed a positive seeding effect of 15 percent increase in rainfall and the second a positive effect of 13 percent increase in rainfall in the northern part of Israel. The results of both the studies were statistically significant at relatively higher levels (Nirel and Rosenfeld, 1995)

In Northern Israel improvements of 10-15 percent in mean yearly precipitation have been measured, but in the southern of the country the methods have not shown evident gains. It is also clear that cloud seeding cannot cause rainfall when there are no clouds (Glick, 1993: 414 and Ohohlsson, 1995:64.).Seeding has created international tensions with claims that improvements in the amount of precipitation in one area comes at the expense of the amount of precipitation in the neighbouring area. According to this argument it is possible, for example, that seeding clouds on the Israeli coast harms the amount of rainfall in southern Syria or northern Jordan. However, this claim has not been scientifically proven. Increased rainfall from cloud seeding between 1976 and 1990 is estimated at six percent. Cloud seeding in the south of Israel has been experimental. Analyses have not indicated any rainfall increase (Rosenfeld and Farbstein, 1992: and Brown et al.. 1996).This result may be due to desert dust, possibly from the Sahara-Arabian deserts, which contributes many nuclei and may reduce the efforts of cloud seeding (Rosenfeld and Farbstein, 1992; Gabriel and Rosenfeld, 1990).

Recent statistical analysis suggests that the cloud seeding experiments have been compromised by statistical errors and that neither of the two Israeli experiments demonstrated statistically significant effects on rainfall from cloud seeding. Cloud seeding is a successful in Israel (North) because it is probably connected with the type of clouds that pass over Israel. Continental clouds are the predominant type while; the clouds which pass over Israel are both continental and maritime. Continental clouds have a narrow range of droplets size than maritime clouds. Maritime clouds are rich in cloud condensation nuclei, consisting mainly of salt, particles that rise with the ocean spray (by breaking waves).A wider droplet range causes shorter droplet growth period and more rain. Therefore it is probably difficulty to squeeze more water out of an efficient maritime cloud by artificial mean. On the other hand, the showering efficiency of the continental cloud is low and thus squeezing is higher.

The research and experience on cloud seeding in Israel is far from complete. Local researches are not oblivious to international research and experimentation in the field. The ultimate research objective is to further explore the unknown of the long and complicated cloud chain of droplet growth. While to a certain extent the effect of the dust component in clouds is clear, reassessment of the regional clouds is needed. For example the distribution of continental and maritime cloud types and the synoptic conditions involved further studies. Such an investigation may affect conceptual models, which would guide further experimental and operational seeding. There is optimism regarding innovation and possible breakthroughs in some other relevant topics for example bacterial cloud seeding. If frost protection can be achieved with antibiotics killing the bacteria that cause freezing, why not apply ice nuclei bacteria to clouds.

The 1992 World Meteorological Organisation statement on the status of weather modification concluded, "if one were able to precisely predict the precipitation from a cloud system, it would be a simple matter to detect the effect of artificial cloud seeding on that system. The expected effects of seeding are, however, often within the range of natural variability...and our ability to predict the natural behaviour is still limited" (WMO, 1992). Since the beginning of the endeavour, there has been international concern about the social and ecological effects of cloud seeding operations and the economic costs and benefits of the cloud seeding technology. In 1979, the WMO and the United Nation Environment Programme (UNEP) considered draft general guidelines for status concerning weather modification, but they were never finalized (WMO/UNEP, 1979).In the 1960s and 1970s, more than a dozen law suits were filed in US over this

(Weiss, 1983).Further research is still needed to clarify the effects of cloud seeding on precipitation. At this time, it is doubtful that cloud seeding would significantly increase water. Moreover, very little is known about its technical and economic feasibility or its environmental impacts. The implications of cloud seeding for present and future generations are similarly unclear.

4.5. Cost Aspect of Desalination

Water cost is a function of capital and operational cost. Both these factors are declining as a result of competitive market pressures, RO membrane technology advances resulting in higher efficiency energy recovery as well as strategic design changes. (Brusilovsky, 2005:233). Two factors that weigh heavily in the evaluation of the economic viability of a seawater desalination plant are the cost of a seawater intake and concentrate outfall. Not only do they represent significant capital and operating costs, their designs are highly site-specific, possibly more so than any other aspect of the plant. They have a considerable impact on the environmental and technical feasibility of the plant itself.

Thermal seawater desalination plants are almost always co-located with a power plant that serves as an energy source for the distillation process. Because electric power plants require large volumes of cooling water to condense power-cycle steam, they are also able to share their seawater intake infrastructure with a desalination plant; this association is further complemented by the fact that the feed water quality required for both processes is virtually identical. Similarly, both facilities can share a common outfall where desalination concentrate is co-mingled with the cooling water discharge. The recent and rapid growth of the seawater reverse osmosis (SWRO) membrane process has complicated this relationship somewhat. SWRO's lower capital and operating costs are competing favourably with thermal desalination processes, particularly for stand-alone desalination facilities where no existing intake or outfall exists. Even if an existing intake were available, the fact that the SWRO process requires a feed water with a much lower suspended solids than cooling water may mean a purpose-built intake has significant process advantages, or even that it is necessary. A desalination plant's seawater intake and concentrate outfall can significantly impact a facility's capital and operating costs. Their designs pose significant engineering and environmental challenges and they often are the determining factor as to whether a plant is economically viable and their importance should not be underestimated (Pankratz, 1999).

4.6. Environmental Aspects

Desalination processes may be characterized by their effluent to the environment, air, nearby land, and to the seas. Desalination is dependent on energy and usually uses fossil energy. All types of air pollution associated with energy production, namely emission of NO_2, SO_2, volatile compounds, particulate, CO_2 and water exist here as well, either by using electricity produced by a conventional power station or by using a dedicated power station. Effluents of desalination plants contain relatively highly concentrated water, which depends on the water recovery from the feed brine. In the case of seawater desalination, rejected brine is concentrated close to twice the original sea water solution. The concentrate also contains chemicals used in the pre-treatment of the feed water.

The more serious problems are those concentrates produced inland, in cases of brackish water desalination. In most cases the solution contains more calcium and magnesium, and sometimes other components are involved, depending on the composition at the source. The problem is less severe when the solutions are purged into the open sea. Where no access to the sea is possible, the concentrate may increase groundwater salinity if allowed to penetrate the earth. A possible solution to that problem includes zero discharge treatment, namely evaporative separation between solids and water, so solids may be stored properly inland. The process is expensive, but the basis for comparison is the cost of brine transportation to the nearest possible authorized area, taking into account the influence of this treatment on the product cost.

Thermal processes may produce water containing five to 50 ppm of TDS, similar in composition to the feed seawater. The RO product may contain 300 to 500 ppm of TDS, basically NaCl and a smaller portion of other salts. Some minor constituents as boric acid, hydrogen sulfide, and CO2 can also be present in the product, depending on the composition of the feed water, but may be removed by adequate post treatment. Post-treatment includes an increase in the pH level, addition of Ca and alkalinity, namely

HCO_3, according to local water regulations (Semiat, 2000:60). Environment should be taken care with these latest techniques.

There are some methods in dealing with the disposal of brine and protecting the environment. They are

4.6.1. Discharging the brines through the outlet of the power station's cooling water

This option suggests using the hot water discharged from the power station for the dilution of the concentrated brines. The main environmental advantage is the high dilution ratio achieved. An additional advantage lies in the relatively low specific weight of the hot water, which would partially offset the high specific weight of the brines and would therefore reduce their tendency to sink to the bottom. In essence it is possible to combine a power plant and a desalination plant, for instance by the shared utilization of the marine environment: via the water feed system, the concentrate flow system, or the evaporation technology as well as in efficient modes of utilization of electric energy and steam. In a paper that presents options for lowering the price of desalinated water, Barak (2000) estimates that the combination of desalination plant and a coastal power station with sea water cooling would result in a eight percent to ten percent reduction to the total cost of the seawater supply systems and the concentrate discharge (Einav,2000:85).

4.6.2. Directing the concentrated brines to a salt production plant

This option, whereby the salts pumped from the sea are utilized for salt production rather than returned to the sea, presents many environmental and economical advantages. If this option is used, there would be an advantage to the additional processing of the brines through the membranes, thereby increasing their salinity at the point of discharge. This option is partially employed in Eilat. The "*Mekorot*" plant in Eilat (which in the past was based on the Zarhin system) is based nowadays on reverse osmosis and produces almost 12 MCM of desalinated water each year. Part of the feed water is brackish water from drilled wells (Nine MCM in concentrations of 3500-6000 mg chlorides per litre) and the rest of the feed is seawater. The volume of the brines generated from the brackish water is reduced by 70 percent, while the volume reduction of brines generated from seawater is 50 percent. It follows that the brines exit the plant at concentrations that are 2.0-2.5 times higher than the concentration of seawater. As the canal passes through an area which is a highly saline marsh and as the flow is by a strong current, it seems that there is no penetration of brine water into the groundwater. The canal's outlet is located in the northern beach area and to the best of our knowledge the rate at which the brine disperses in the sea has not been monitored.

4.6.3. Direct discharge of the brines at the coastline

The option of discharging concentrated salt solutions directly at the coastline under certain conditions (small plants, insensitive shore) and be given some consideration because of economical factors. As the brine water is continuously returned to the sea it forms a plume of high salinity seawater, depending on the marine conditions and other factors. The effect is noticeable at distances of hundreds of metres from the outlet (depending on the amounts of the brines). Even if the brines would be mostly diluted at a short distance from the outlet, during the many days in which the sea is calm (such as during easterly winds), the secondary dilution would be negligible. On those days the damage to the coastal habitats would be high. This method is not recommended for seas with high sensitivity, or for large desalination plants, nor for areas with population of high environmental awareness. This is not recommended in the case of Israel (Einav, 2000: 86).

Therefore, with regard to alternative sources of water, Israel could meet its escalating water demand though a variety of sources. Desalination of water, however, is the major solution to meet the increasing gap between the demands and supplies of water. Though there are different sources of alternative sources of water desalination of seawater is considered as economic especially for when taken in large-scale using reverse osmosis technology for domestic and industrial use. Desalinated brackish water emerges to be the suitable solution to meet the agriculture sector which consumes more than 50 percent of the Israel's water. Treated effluents from domestic and urban area also meet the demand of water to some extent particularly in the agriculture sector though there are some environmental drawbacks because of soil pollution and aquifer salination. Importation of water from Turkey is a positive step to meet the water requirement though it includes political and international constrains. Cloud seeding is a minor source of alternative source helps to replenish the Lake Kinneret where the dissolved salts concentration is increasing and also little amount of fresh water in the southern Israel. In terms of cost of the desalinated water it depends up on the method used and the capacity. Reverse Osmosis technique promises to be the economic one if it is conducted in large scale. Given the growing gap between demand and supply, Israel's future water demands would have to be met by alternative sources.

Chapter 5

Conclusion

Water policy in Israel has evolved through different phases whereby importance was given to different aspects like Zionist ideology. Agriculture and institutional framework was prominent during the first period, while the second period concentrated on agriculture and expanding the water source by acquisition of water resources from occupied territories. The third sought to meet the increasing demand of water by alternative sources and protecting the existing water sources. Though agriculture played a dominant role in the Israel water sector by demanding large allocation while paying lower prices, it is losing its centrality in the water policy of Israel. Drop in the share of agriculture in the GDP and declining share of labour force in the agriculture sector significantly contributed to this trend.

The transfer of water sector to the Ministry for National Infrastructure from the Ministry of Agriculture in 1996 was a major shift in the water policy in Israel. Though the Ministry of Agriculture played a major role in water policy for several decades through the appointment of Water Commissioner and having a strong agricultural lobby, it could not keep its momentum when the water sector is transferred to Ministry for National Infrastructure.

As a result, the original power of agriculture lobby has declined in demanding water quotas and subsidized water prices compared to the other users. The political power of agriculture sector in water has dwindled. This is reflected by the shrinking land area under agriculture and the land use pattern in Israel. Though the agriculture sector holds a historical and ideological support in gaining the major stake in water sector, it failed to sustain it in long run because of immigrants belong to different professions and no longer have the historic commitment for *"Making the desert bloom"*.

The Ministry of Finance through its authority can persuade higher price of water for agriculture by scraping the lower price rate through cuts in quotas and block rate tariff. The water policy which was once intertwined with agriculture policy is no more in part of it. At the same time, it holds a strong position through the agriculture lobby which attracts the policy makers to be favourable towards the agriculture sector.

If one looks in to the institutional set up of water making policy in Israel, it is rather disorganized and intertwined with many players. The public inquiry conducted by the Knesset in 2002 clearly highlighted the inherent tension and conflict among various agencies and ministries dealing with water. Currently there are 11 ministries which deal with the water sector in combination with the additional bodies involved. The multiplicity of ministries not only creates duplicity but also lead to inefficiency in evolving and implementing a coherent water policy. None of the players have absolute control over subjects they are meant to control.

This certainly create problem in bringing effective use of water and protecting scarce resources. Though there are Ministries which seek for the protection of existing water resources and maintain their quality, there are others who seek greater usage of water by demanding more allocation and additional exploitation of these resources. Different ministries have different goals. Hence, there is no clear delineation of authority over different components and none of the players have complete control over the issues.

The legislative framework of water policy is mainly based on the Water Law 1959 and other Laws which deal with different aspects of water sector. The Organisational framework of water policy ends up with multiplicity of Ministries and other stakeholders and in turn leads to conflict between them and thus poor result. To overcome this, the Water Commission should be made in to an independent professional water authority and not to be subject to any Ministry and should be headed by a water expert. This could significantly decrease the multiplicity of ministries and other bodies regarding water and bring efficient use of water and better management of water.

The increasing demand for water because of population growth, influx of immigrants, urbanization and industrialization and depleting quality of water sources resulted in Israel looking for alternative sources of water. The major source is through desalination and is carried out along the coastal area for reducing the cost of transport of sea water and disposing the brine in to the sea. Israel has more brackish water which is also desalinated and mainly replaces the freshwater allocation in agriculture. This creates pollution in land by increasing the salinity, but technology helps in producing salinity resistant crops. One of the major disposals of water is the sewage from the domestic sector and the effluents from industry, which is also treated and used for agriculture. The other minor alternative sources of water are cloud seeding and possible import of water from Turkey. At least in the short run, desalination appears to be the only major solution for the ever increasing demand for water in Israel.

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