WATER RESOURCE MANAGEMENT IN THE NORTHERN JORDAN VALLEY

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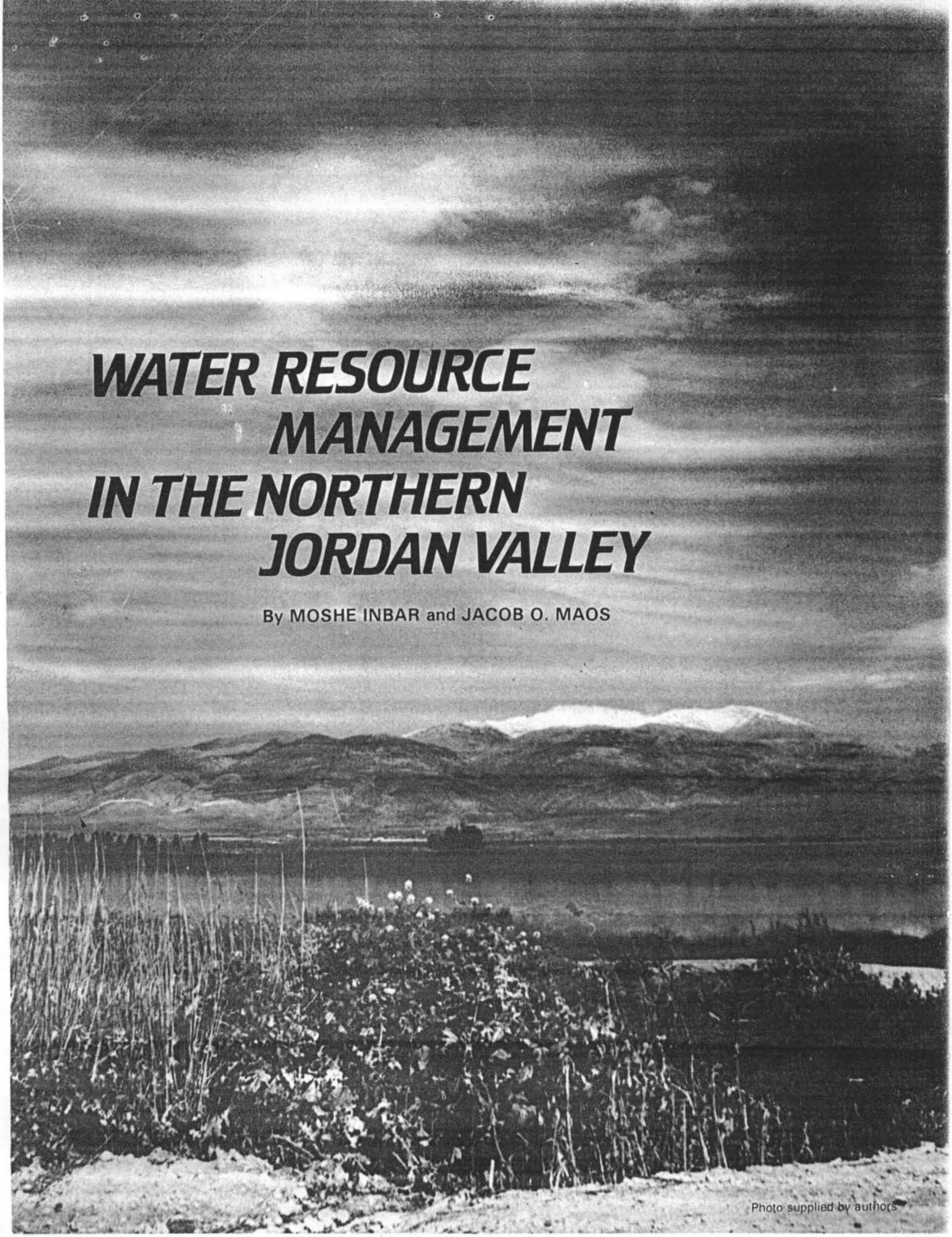

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EDITOR'S NOTE: This scholarly article provides evidence — once again! — that politics often are part of the problem rather than of the solution. Convincingly — at least to the Editor — the co-authors conclude that "the argument of water scarcity as a reason for all-out conflict is refuted by the fact that it was possible to withdraw substantial quantities of water from the Kinneret (Sea of Galilee) reservoir for irrigation on the Golan Heights without impairing the functioning of the system or creating major shortages." *And as for the future, "further demographic growth and economic development in the region, and the attendant intensification of water uses* will put a premium on growing coordination among all the co-riparian states..."

Physical Features

Countries usually consider water as a national resource at their sovereign disposal. Yet, the sources of water — the catchment area, river basin boundaries and river channels — are not always respecters of political borders and often transcend them. Although relatively small, the Jordan River Basin epitomizes many of the problems of water resource management which occur in other parts of the world on a broader but equally complex scale. The constraints of a highly intensive water management system, and the necessity for an optimal utilization of all natural resources, are compounded in the Jordan River Basin by the particular geo-political structure of the region to which Israel is bound by the heritage of its past and recent history.

Many a visionary and planner has been intrigued by the inherent potential for the development of the Jordan Valley. Among the first to translate these ideas into tangible engineering concepts was W.C. Lowdermilk who realized the opportunity to apply to the Jordan Valley the experience acquired in the development of the Tennessee Valley Authority of the United States.

The physical setting of the Jordan-Kinneret Basin (Fig. 1) is an elongated valley, 100 kilometres in length, varying in width from 20 to 40 kilometres, situated between Latitude 32°48' and 33°29' North; and Longitude 35°35' to 35°53' East. It covers an area of 2730 square kilometres and drains the Northern Jordan Rift Valley.

Left: General View of the Hula Valley and Mt. Hermon near Jordan River

Its general outline is determined by the geologically young tectonic features of the Rift, one of whose last phases caused the formation of the body of water variously known as Lake Kinneret, Lake Tiberias or the Sea of Galilee, some 18,000 years ago. Elevations range from 2,814 metres at the Mount Hermon summit to *minus* 210 metres at lake level.

The natural system of the Jordan River and of Lake Kinneret (which acts as an *intermediate* lake) drains toward the Dead Sea situated at 398 metres below sea level. Physiographically, the basin is characterized at the North and on both flanks by mountainous ranges and by a central part covered by alluvial plains. The mean annual precipitation for the Lake Kinneret watershed is 790 mm, ranging from 1,600 mm in the upper area, to 400 mm in the South, over the lake region.

The Jordan River supplies an average of 650 million cubic metres of water per annum, or about 40% of Israel's total water budget. Its main sources are the Hermon karstic springs, and the flow is continuous throughout the year, averaging from 18 million m^3 in August to 75 million in February. Stormflows occur as a result of heavy precipitation in the northern part of the catchment area and in the Hula Valley. Flooding takes place when precipitation reaches an intensity of 50 mm per day in the Hula Valley. Over the 22-year period from 1959/60 to 1980/1, the *mean* annual water flow entering Lake Kinneret was 521 million m^3. This figure represents the net flow, after deducting an estimated quantity of 110 million m^3 consumed in the upper basin.

Regional Water Development Schemes

The Lowdermilk Plan (1942) envisaged the diversion of the sweet waters from the Upper Jordan and the Yarmuk River (a major tributary entering the Jordan River south of Lake Kinneret) into open canals or closed conduits running around the slopes of the Jordan Valley. Dr. Walter C. Lowdermilk also noted the difference in altitudes between the Jordan Valley and the Mediterranean Sea which offered a splendid opportunity for a combined power and irrigation scheme (Fig. 2). Several of these ideas were later incorporated into a detailed technical report prepared by the *Commission on Palestine Surveys*, which foresaw the utilization of water resources on a regional scale, including the use of groundwater, interception of storm run-off, drainage of the Hula Lake and swamps, and irrigation of the lower Jordan Valley. The Commission suggested that all head-streams of the Jordan River should be col-

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Fig. 1: Natural and political divides in the Jordan-Kinneret watershed (drainage are = 2700 km²)

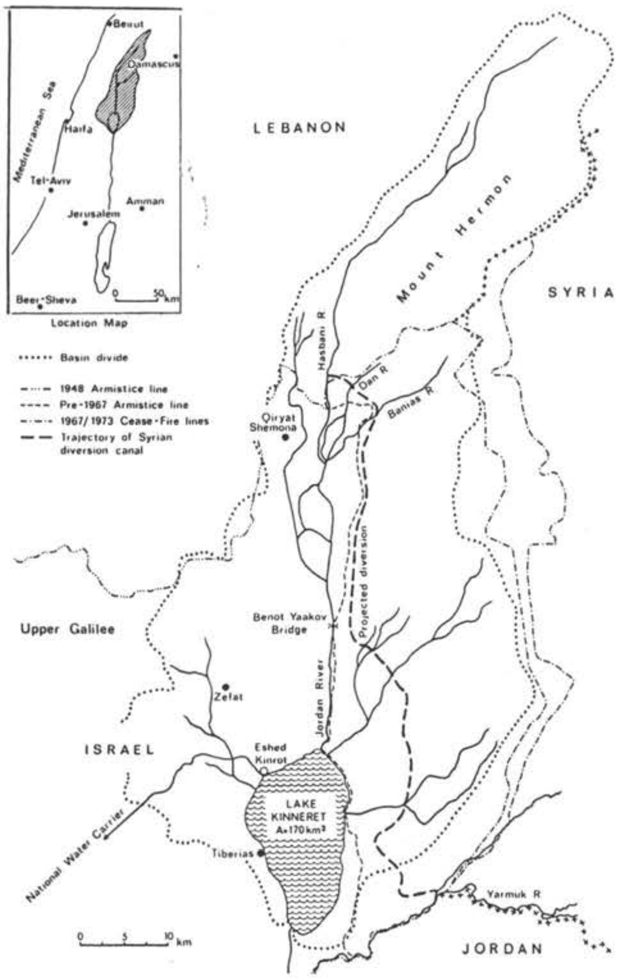
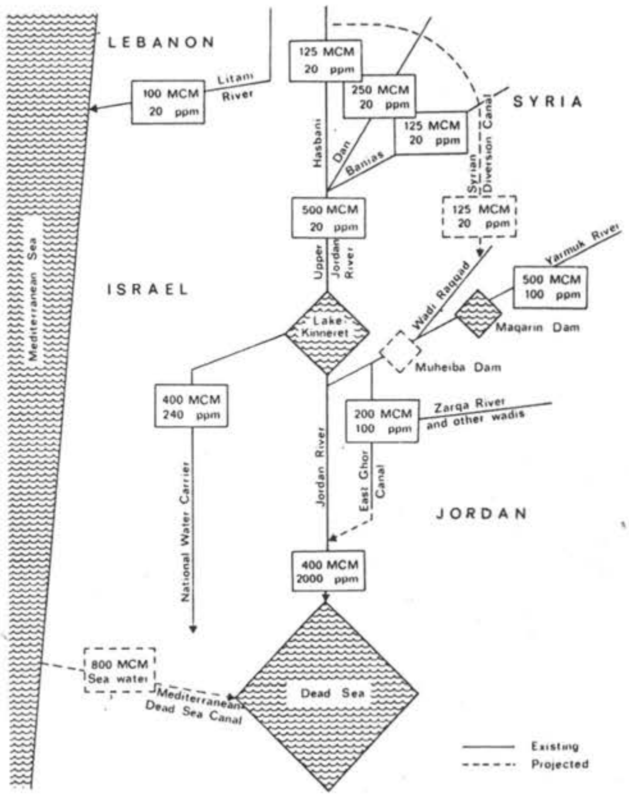


Fig. 2: Schematic map of water system in the Jordan River catchment area, showing approximate yearly flows in million m³ (MCM) and salinity in parts per million (ppm).



lected by a countrywide water-carrier and diverted near their sources, thus enabling flow by gravitation with a minimum amount of pumping. Headwater from the Litani River (in Lebanon, north of the Jordan River) was to be fed into the Hula Valley, thus augmenting the quantity of water available for irrigation and hydro-electric power, and the Yarmuk River was to be diverted to Lake Kinneret. Ultimately a seawater canal from the Mediterranean to the Dead Sea was to be built in order to replace the flow of the Jordan River and to generate additional hydro-electric power. These proposals, as well as other projects embodying similar concepts, were the forerunners of a unified plan for the integrated development of water resources in the Jordan Valley prepared in 1953 at the request of the United Nations; known as the (Eric) "Johnston Unified Water Plan", it became the basis for extensive negotiations between several Arab States and Israel.

Various components of the original scheme such as the use of water from the Litani River or the Mediterranean-Dead Sea hydro-electric project, were subsequently discarded either because they proved not to be feasible or because of opposition from the Arab States.

The final plan regarded Israel, Jordan and Syria as co-riparian States to the Jordan and Yarmuk Rivers, while Lebanon was recognized as a riparian to the Jordan Basin. The plan took into account the development schemes prepared separately by Israel and Jordan, and made provisions for supplying as far as possible the full quota of water stipulated by the governments concerned for the irrigation of their farmlands. Nevertheless, although the Johnston Plan was endorsed by *experts* of both sides as a logical and equitable approach to the joint development of the river system, it was rejected by the Arab League Council on *political* grounds.

Israel and Jordan thereupon proceeded to work separately, each on its own modified water development scheme, i.e. the National Water Carrier Project (Israel) and the Great Yarmuk Project (Jordan, in cooperation with Syria). Both projects were basically in line with the Johnston Plan and can be described as follows:

ISRAEL: The National Water Carrier Project

The National Water Carrier extends from the Upper Jordan Basin through nearly the full length of the country, linking up with, and interconnecting, existing branch networks and local drainage, storage and irrigation systems.

Its design derives from the marked difference in rainfall between the northern and southern parts of the country, seasonal variations and regional drought situations. Another characteristic is the availability of water at elevations *below* sea level in the North (Lake Kinneret lies 210 metres below sea level) which has to be conducted to the South for lands suitable for irrigated and mechanized cultivation at elevations *above* sea level.

In order to overcome these shortcomings and to coordinate the water supply with other existing systems, a 200 km-long trunk line was built to carry water from the Upper Jordan Basin to the South. The carrier comprises a complex of canals, pipelines, and tunnels, with a capacity conforming to the water allocation of the Johnston Unified Water Plan.

Originally, the National Water Carrier called for the withdrawal of water directly from the Jordan River at Benot Yaacov Bridge, situated between Lake Hula and Lake Kinneret. This location, being above sea level, would have allowed gravitational flow and the descent of excess winter flows into Lake Kinneret for storage and generation of electric power. In 1953, however, Benot Yaakov was within the demilitarized zone between Israel and Syria, and when construction on the intake structures began, Syria protested to the United Nations. As a result work was suspended pending the outcome of the debate in the Security Council, and Israel embarked on the building of an alternate intake at Eshed Kinrot, on Lake Kinneret.

JORDAN: The Great Yarmuk Project

The Jordanian project was planned so as to provide in its ultimate phase about 700 million m³ of water a year for irrigation and hydro-electric power, mainly from the Yarmuk River but partly also from the Lower Jordan River Basin and from several small tributaries. The Muzeirib phase was designed to withdraw 70 million m³ of the Yarmuk headwaters for the irrigation of an arid farming region in southern Syria. The main part of the project was the construction of the East Ghor Canal for the irrigation of traditional farming areas and formerly undeveloped arable lands in the Jordan Basin between the Yarmuk and Zarqa Rivers. A 900 metre-long tunnel was built to conduct the water from the Yarmuk headstream to the 70 km-long East Ghor Canal running down to the south, roughly paralleling the course of the Jordan River. The amounts of water carried by this canal were augmented by the damming of several small wadis (side streams) in the area. The completion of this part of the Yarmuk Project coincided with the inauguration of Israel's National Water Carrier in 1964. By 1979 the East Ghor Canal had already reached a length of 100 kilometres and a further extension was planned to bring the canal nearer to the Dead Sea.

In order to impound the winter flows of the Yarmuk Basin, two dams were projected: the Maqarin Dam, about 35 km east of the Yarmuk-Jordan confluence; and the Haled Dam, some 20 km east of the same confluence. Both locations, however, did not fit in with certain Arab plans for diverting part of the Jordan River headwaters to the Yarmuk River. An alternate downstream location was therefore chosen at Muheiba, near Hamat Gader, about 10 km east of the Yarmuk-Jordan confluence. Construction of this dam was started in 1966 but interrupted by the 1967 war. It was later continued at the Maqarin site and will presumably be completed by 1985.

Although the Johnston Plan was officially rejected by the Arab States, it was adopted *in practice* by Israel and Jordan: both countries accepted, even if not formally, the water allotment laid down in the Johnston Plan. Israel proceeded with the building of its National Water Carrier, while Jordan carried out its own irrigation development programme of the East Ghor Canal.

In 1964, shortly before Israel started to pump water from Lake Kinneret into the National Carrier System, the Arab League decided to divert part of the Jordan River headwaters, so as to prevent their flowing into Israeli territory. The Arab plan called for the diversion of the Hasbani River in Lebanon to the Litani River by way of a tunnel, and for diverting the flow of the Wazani and Banias springs to the Yarmuk River by means of a 70 kilometre-long canal which would cause the water to flow into the Raqqad River, a tributary of the Yarmuk (Fig. 2). The Banias-Yarmuk canal was to be constructed against the rising slopes of the Golan Heights at an elevation of 350 to 300 metres above sea level, in some places within short distance from the Israeli border.

The planned carrying *capacity* of the canal was to be 17 million cubic metres per month, but since such flows occur only between December and April, the annual quantity of diverted water would be only about 125 million cubic metres, including the Hasbani waters destined for use in Lebanon and Syria. When fully operative the canal would deprive Israel of about one-third of the installed capacity of its National Water Carrier. Moreover, the partial removal of saltless headwater would increase the salinity of Lake Kinneret — the main reservoir of the Israeli water system — by about 60 parts per million.

A study of the potential applications of the diverted water in the three countries involved in the scheme revealed only marginal returns. From either an economical or engineering point of view the execution of the plan appeared rather unrealistic, mainly because of the rugged terrain along the canal's proposed trajectory.

It is worthwhile to dwell briefly on the dynamics which brought about the diversion plans: toward the end of the 1950s and beginning of the 1960s, the Arab world was divided into a triangle of opposed camps: Egypt; Iraq; and the so-called Conservative States. With the dissolution of the United Arab Republic in 1961, Syria became yet another factor in this antagonistic framework.

The Arab-Israeli conflict was frequently the central theme of political dispute among Arab States. In the course of mutual allegations of neglecting Arab national interests, the significance of Israel's Water Carrier Project was blown up beyond all proportion and branded as a crucial step in the new State's socio-economic development which allegedly had to be halted before Israel became a solid reality.

The gradual escalation of border incidents which erupted into full-scale war in 1967 put an end to the diversion project, while the consequential changes in the geo-political space containing the region's water resources neutralized, for the time being, the Jordan headwaters as a tool of political manipulation.

In the aftermath of the 1967 war, development was continued in two areas: the Hula Valley and the Golan Heights. In the Hula Valley drainage and canalization work, formerly obstructed by Syria, could at last be carried out and was in fact concluded in 1971. The main purpose was to reduce flooding in the Hula Valley by lowering the water level of the Jordan River and to enable faster drainage of storm run-off. Since the completion of this work, no flooding has been recorded in the Hula Valley.

In the Golan Heights a large-scale agricultural development programme was initiated, envisaging the irrigation of 9,000 hectares of crops by means of an annual water allocation of 54 million cubic metres.* Already by 1980 about 22 million cubic metres of water were provided for the irrigation of some 6,500 hectares, apart from the consumption of water in the Druze villages on the Golan Heights.

The manifold increase in water supply to the Golan Heights was made possible by developing local resources and by drawing water from Lake Kinneret. The development of local water resources comprised drilling for groundwater and the construction of dams for impounding winter storm runoff. Sixteen dams with a total storage capacity of 10 million cubic metres were planned and several of them are already in operation. Tapped groundwater and local springs further increased the water supply by several million cubic metres a year. On the southern Golan — an area devoid of natural water resources, but possessing the major concentration of arable *land* — water is supplied through pumping from Lake Kinneret.

Except for minor quantities in the eastern part which would normally drain into the Yarmuk Basin, most of the water available on the Golan Heights actually forms part of the Jordan-Kinneret watershed. In other words, the agricultural development of the Golan Heights draws mainly on Israel's own water resources. But in spite of the substantial amounts of water thus withdrawn from the country's main supply, the efficiency of the system has not been impaired. Even the future utilization of 6 to 7 per cent of the Jordan Basin's total water yield is not expected to cause major problems or shortages.

To date Israel's Water System has been able to accommodate, within bounds, most national requirements for agriculture, industry, and domestic needs and is expected to be capable of absorbing fluctuations resulting from an erratic climate and a growing economy. Much of this has been achieved through rationalization, particularly in agriculture, with the introduction of new technologies such as drip and trickle irrigation. Planners are confident that current reserves and seasonal replenishments are adequate to meet the bulk of the demand for which the entire system was designed. Even so, however, future population growth and the expansion of farming may require the development of new or non-conventional sources of water in the 1990s.

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* Before 1967, there was hardly any irrigated land in this area, as can be deduced from the markedly low water consumption — about 1 to 2 million m³ per annum — for livestock rearing and domestic use.

The operation of an integrated and centrally-controlled water system has afforded considerable flexibility and regulative capacity for meeting fluctuating demands and varying situations. However, when used to the limits of its capacity, such a system (functioning practically as a closed one) must depend increasingly on a delicate balance between quantity and quality.

Salinity has probably been the most complex problem encountered during the various stages of the project. Contrary to earlier plans, the Yarmuk River was diverted directly to the East Ghor Canal rather than be allowed to flow first into Lake Kinneret whose diluting effect was thus lost. The Arab Diversion Plan, if implemented, would have still further exacerbated the salinity problems in the system's main reservoir.

At present the salinity of Lake Kinneret amounts to approximately 240 parts per million, compared with 20 parts per million at the Jordan point-of-entrance to the lake. Although a salinity of 240 parts per million can be tolerated for some agricultural uses, it is considered too high for the irrigation of citrus groves which produce one of the country's major export crops. The diversion of saline springs from the shores of Lake Kinneret and the abundant rains of the year 1968/9 helped to lower the chlorine content of the stored water which is expected to remain at present levels.

Another problem is the rapidly expanding role of the Upper Jordan Basin and Lake Kinneret as an inland recreation area. The Israeli withdrawal from Sinai following the Peace Treaty with Egypt and the evacuation of numerous beach resorts and recreational facilities along the Red Sea coast have already begun to attract large numbers of vacationers to the northern riverine region and lake shores. The environmental impact of these stepped-up recreational activities is expected to compound the problems of water quality already caused by agricultural and urban effluents. As the system approaches the physical limits of the available water supply, appropriate devices and planning measures must be utilized to permit the existing system to function in enhanced harmony with the environment. Such measures will require, inter alia, enlarged administrative capacity and improved management techniques.

In retrospect, it is obvious that the Syrian diversion plan was basically politically motivated and that no real advantages in terms of economic benefits were to be gained from the project for the States concerned. That, apart from its questionable feasibility, both from economical and engineering standpoints, the diversion plan was primarily a political move, is further confirmed by the fact that after the cessation of the 1967 hostilities, the Jordanian Government quietly resumed the development of the Yarmuk River sources as *originally* contemplated.

While water continues to be a vital commodity in the Jordan River Basin, the argument of water scarcity as a reason for all-out conflict is refuted by the fact that it was possible to withdraw substantial quantities of water from the Kinneret reservoir for irrigation on the Golan Heights *without impairing the functioning of the system or creating major shortages.* In the long run, population growth and agricultural development may require new and non-conventional sources of water for the region. At the same time, however, it seems that *quality rather than quantity will remain the overriding criterion in the region's water resource management.*

The implications of a closed and intensively-used water system can already be noticed in several areas. Apart from salinity — still one of the major concerns — there is the problem of a gradual deterioration of water quality, expressed in terms of growing pollution along the Upper Jordan River. Since the National Water Carrier was planned to conduct *potable* water, health hazards penetrating the system may very soon become of critical importance. The draining of the Hula Valley has also increased the flow of nutrients to Lake Kinneret, while the flushing of long-lived pesticides into the system's main reservoir constitutes another health risk through the contamination of drinking water and fish life.

From an environmental standpoint the growing urbanization in the catchment area and the addition of untreated sewage from uncontrolled sources are particularly critical issues. The growing importance of the Upper Jordan Basin and Lake Kinneret as inland recreation areas adds yet another facet to the pollution problems already caused by agricultural and urban effluents. Last but not least are the changes wrought by the retention of water which may affect both the natural and historical landscapes for which the Jordan River is famous. Although pollution can be alleviated by dilution, it is clear that within the given limits of the Jordan River Basin mere quantitative considerations cannot serve as a substitute for the need for rational and meticulous planning to meet future demands.

Evidently the conflict over water in the Jordan Basin stems, to a considerable extent, from human interference with Nature's delicate ecological equilibrium. Further demographic growth and economic development in the region and the attendant intensification of water uses will put a premium on growing coordination among all the co-riparian States in the not-too-distant future.●