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The Palestinian Water Crisis: Status, Projections and Potential for Resolution

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Abstract

The Middle East is renowned as a water scarce region. The severity of the problem in Palestine is not a result of climatic misfortune, however, but of regional political problems: specifically, shortage has been caused by the Israeli occupation policies. Palestinians' water supplies are currently insufficient to cater for demand, and are increasingly degraded. Projected regional population and demand increases are high, rendering coming to grips with the water shortage urgent. Any attempt at resolution should consider three related areas within a single integrated water management formula. Firstly, attempts must be made to resolve allocation disputes, governed by principles of international water law; secondly, supplies must be enhanced, either through water import or water catchment; and thirdly, conservation and appropriate utilization must be emphasized. Only if the water shortage is analyzed in such an integrated manner will it be possible to ensure full resolution of the Palestinian-Israeli hydropolitical dispute.

Introduction

Throughout the Middle East, the natural facts of water supply and the socio-political facts of water control, consumption and demand interplay to form a complex hydropolitical web. The allocation of the region's three major river basins - the Nile, the Euphrates-Tigris and the Jordan - are nascent sources of tension, and potential sources of conflict. Syrian-Turkish relations are strained over Turkey's South East Anatolia Project, and Egypt is concerned about possible Ethiopian development of the Nile. Of all the Middle East's river basins, however, it is the Jordan that hosts the most fraught and inflammable dispute. It is this latter area that will be the focus here. Above all, the emphasis will be upon the hydropolitical situation in Palestine (which is defined as the West Bank, including East Jerusalem, and the Gaza Strip) and Israel. Hydrologically, as well as politically, the Palestinian-Israeli conflict lies at the heart of the wider Arab-Israeli conflict. Hence Palestine and Israel should be central to our fear of yet more conflict, and pivotal to our hopes for peace and regional development.

Only limited recommendations for resolving the Israeli-Palestinian water conflict will be made here. Instead the focus will be upon clarifying hydrological and political facts. Thereafter it will be the reader's prerogative to consider the ways in which an equitable -

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and therefore sustainable - peace can be achieved.

Physical Geography

Topographically, Israel and Palestine are characterized by three zones: (1) a coastal plain which rises up to 200 m above sea level, and stretches from northern Israel to Gaza; (2) a limestone mountain ridge, reaching elevations of up to 1000 m, most of which lies within the West Bank; and (3) the Jordan Rift Valley, located on the eastern rim of Israel and the West Bank, which drops to almost 400 m below sea level. The topography of the Palestine is shown in Figure 1.

Palestine and Israel have Mediterranean climates, which are characterized by dry summers and cool wet winters. 70% of total annual rainfall falls in December, January and February: typical patterns are shown in Figure 2, which presents rainfall histograms for Hebron and Tulkarem, located in the northern and southern West Bank respectively, for the years 1991 and 1992. There are, however, substantial regional variations, conditioned by two factors: (1) Palestine and Israel are intermediate between the subtropical rainy climate of Lebanon and the subtropical arid climate of the Negev and Sinai. Hence northern areas receive more rainfall than southern areas. (2) The region's topography is a strong determinant of rainfall patterns. Highest rainfall is recorded where the land rises from the coastal plain, and on the mountain ridge's western rim. The eastern highlands and the Jordan Valley are rainshadow areas. The resultant distribution of rainfall is illustrated in Figure 3.

Potential evaporation is similarly subject to local variations, although it exceeds rainfall throughout Israel and Palestine. On average, 75% of rainfall is immediately lost through evaporation.

The Jordan River international drainage basin offers precious water resources to all its riparians: Palestine, Israel, Jordan and, to lesser extents, Syria and Lebanon. The chief headwaters of the Upper Jordan are the Dan, Hasbani and Banias Rivers, which rise in Israel, southern Lebanon and the Golan Heights respectively. These sources feed Lake Tiberias, below which the lower Jordan flows into the Dead Sea. The Yarmouk River, the headwaters of which are in Syria and Jordan, joins the Jordan River 10 km below Lake Tiberias; additionally, a number of minor tributaries and springs in Jordan, Israel and Palestine feed the lower Jordan and the Dead Sea, from which there is no outflow. The Jordan River basin is illustrated in Figure 4. Table 1, meanwhile, shows the extent to which these various surface water sources contribute to the Jordan's discharge.

The Jordan basin is not, however, the only water resource to which Israel and Palestine are co-riparians. Westward-flowing mountain aquifers straddle the Israel-West Bank border: while their recharge areas are largely in the West Bank, water surfaces in Israel. In addition, the coastal plains of Israel and Gaza share coastal aquifers where there is

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potential for salinization given mismanagement of resources. Underground sources constitute the most important water resource in the region; surface waters contribute only 30% of total supply in Israel and Palestine (Zarour and Isaac 1991).

The hydropolitical situation

Israel currently has control over the major part of the Jordan basin. Through its control in southern Lebanon, Israel is able to limit Lebanese exploitation of the Hasbani River; through the occupation of the Syrian Golan Heights, Israel controls the Banias River and minor eastern tributaries of Lake Tiberias. The Jordan headwaters are stored in Lake Tiberias, and transferred, at a rate of around 1.5 million cubic meters (mcm) per day, into the National Water Carrier, which supplies coastal and southern Israel with water (Rudge 1992). Israel also diverts an estimated 70-100 million cubic meters per year (mcmy) from the Yarmouk to Lake Tiberias (Isaac 1994).

While occupation of Syrian and Lebanese territory allows Israel to control the upper Jordan, occupation of Palestine allows Israel to control, and restrict Palestinian access to, West Bank aquifers. Crucially, Israel controls utilization of the West Bank's mountain aquifers, as Table 2 suggests, thus resulting in an increased rate of replenishment of Israel's groundwater and an increased supply within Israel. Stringent occupation policies prevent Palestinians from fully exploiting the West Bank's groundwater:

* The military authorities have expropriated wells belonging to absentee owners, as well as those within the boundaries of confiscated Palestinian land.
* Permission for well-drilling must be obtained from the military authorities. Permits have been granted only 23 times since 1967. Only 3 of the resultant wells were for agricultural use (The Water Commission 1993).
* Rigorous water quotas are imposed on Palestinians. Excess pumping is punished by heavy fines.
* Supply is often restricted, leaving communities without water for considerable periods.
* Palestinians are forced to pay extortionate rates for their water supply. Settlers pay $0.40 per cm for domestic water and only $0.16 per cm for agricultural water, the latter being highly subsidized. Palestinians, by contrast, pay a standard rate of $1.20 for piped water. 26% of Palestinian households have no piped water (Isaac et al 1994a). Hardly any of the irrigated areas in Palestine are supplied with piped water.

Israel meets its water demands through this control of the Jordan River basin and the West Bank's mountain aquifers. As Figure 5 illustrates, 25.3% of Israeli water is derived from West Bank aquifers; a further 30% of Israel's water consumption is met by exploiting Lebanese, Syrian and Jordanian sources. Internal sources account for only 44.7% of Israeli water consumption.

While the consequences of Israel's water monopoly on the West Bank are severe, the situation is much worse in the Gaza Strip. An arid area, located above the shallow aquifer

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which abuts the Mediterranean, Gaza lacks the plentiful water resources of the West Bank. Gaza currently has an annual 65 mcm of renewable water, constituting a water deficit, as over 100 mcmy are extracted from the Strip's aquifers, which are dropping by 15-20 cm per year, and becoming increasingly saline (Shawwa 1993). The situation is rendered critical by a number of factors:

* Gaza's water crisis is largely a result of its high population density, and this in turn has been caused by the successive displacement of Palestinians. Prior to 1948, the Gazan population was only 50,000; now over 800,000 Palestinians are packed into an area of 365 km^2.
* The 3500 Israeli settlers in Gaza consume 6 mcmy, and per capita quantities far greater than Palestinians (Shawwa 1993).
* The waters of Wadi Gaza would naturally add to Gaza's water supply, were they not currently impounded upstream. Additionally, 44 mcmy of groundwater that would naturally replenish Gazan aquifers are extracted by Israeli wells on the outskirts of the Strip (Shawwa 1993).

This hydropolitical situation has clear environmental impacts in Gaza, above all the salinization of groundwater and wastewater pollution. Similarly, the lower Jordan River is increasingly ecologically damaged. Not only do Palestinians suffer through being prevented access to Jordan waters. The lower Jordan, as a result of water diversion into the National Water Carrier and the diversion of saline water to below Lake Tiberias, is an increasingly saline trickle, the quality of which is too poor even for agricultural use. In 1953, 1250 mcmy flowed under the Allenby Bridge, just a few miles upriver of the Dead Sea (Main 1953); nowadays, annual flow into the Dead Sea is a mere 152-203 mcm (Soffer 1994). The water in the lower Jordan is also highly polluted.

Patterns of consumption

Table 3 demonstrates total annual consumption and per capita annual consumption for Israel and Palestine, revealing that the average Israeli consumes three and a half times that of the average Palestinian. Additionally, the table shows the contrasting consumption levels between Israeli settlers and Palestinians, in both the West Bank and Gaza. In the West Bank, per capita settler consumption is seven times that of Palestinians, while in Gaza, settlers consume almost thirteen times as much as Palestinians. These differences reflect the fact that settlers are not subject to the restrictions of occupation.

Current water supplies in Palestine are simply insufficient to cater for domestic demand. Palestinians suffer from intermittent supplies of piped water, and are often forced to survive on tanked supplies for periods of several months. Some areas of the West Bank district of Bethlehem were without piped water between May and October, 1994. Comparable shortfalls in domestic supply are unknown in Israel.

Table 4 shows sectoral consumption levels in Israel and Palestine, illustrating the contrast between Palestinian and Israeli domestic consumption levels, and pointing to one of the

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chief culprits of the regional water crisis. 75% of Israel's supplies are used for irrigated agriculture, a proportion considerably higher than in Palestine. This is despite the fact that agriculture is of peripheral importance to the Israeli economy, accounting for only 4% of Israel's GDP and 3.5% of its employment. Agriculture is much more central to the Palestinian economy, representing over 25% of both GDP and employment. Nearly half of Israel's cultivated land - and 70% of West Bank settlers' cultivated land - is irrigated; by contrast, all but 6% of Palestinian cultivated land is rainfed. The relative importance of agriculture in Israel and Palestine, as well as the contrast in water consumption between the Palestinian and Israeli agricultural sectors, is shown in Table 5.

Projected demand increases

The prospect of substantial water demand increases in the coming years renders finding a solution to Palestine's water shortage absolutely imperative. Both the Israeli and Palestinian populations are expected to increase dramatically in the coming years, as shown in Table 6, and population increase is bound to heighten demand.

Demand projections for Palestine are shown in Table 7. The calculations are premised upon the aforementioned population growth projections, and upon the lifting of current restrictions on water supplies. Thus the projection assumes both a higher population and an increased per capita water demand. Industrial water demand is expected to increase at an annual rate of 10% up to 2000, declining thereafter: this pattern reflects a rise in the volume of the tourism and construction industries, which are likely corollaries of the lifting of occupation in the West Bank and Gaza. The projections for agricultural water demand, meanwhile, are premised upon the expansion of irrigation to areas that are well-suited for irrigated agriculture, and upon Palestinian utilization of land that is currently irrigated by Israeli settlers.

In Israel, water demand is not expected to increase at the same rate, chiefly because levels of supply, especially for the domestic sector, are adequate. Nevertheless, immigration is likely to continue to result in a high rate of population growth, and economic growth will further increase demand. Future demand will vary in accordance with the extent to which agriculture is irrigated, the extent to which further irrigation technologies are developed, and the extent to which the real cost-price of water is charged. Eckstein and Fishelson estimate that total demand will increase by over 400 mcm by 2020, to 2171 mcmy. All projections are necessarily tentative; nevertheless, the clear picture in both Israel and Palestine is one of upwards-spiralling demand. Any moves towards resolution of the Israeli-Palestinian riparian dispute must incorporate an understanding, not only of the current hydropolitical situation, but also of probable future changes in demand.

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Resolving the Israeli-Palestinian water dispute

The Declaration of Principles, signed on 13 September last year, was a watershed in Palestinian-Israeli relations. Subsequent agreements - namely the Cairo Agreement of 4 May 1994, which detailed the terms of Palestinian self-rule in Gaza and Jericho; and the Erez Agreement of 29 August 1994, which enabled the transfer of certain powers and responsibilities in the West Bank - make it clear that the parties are cautiously moving towards a political resolution to the Palestinian-Israeli conflict. The Jordanian-Israeli Peace Treaty (27 October 1994), meanwhile, further heightens the prospect of a regional political settlement.

Given the current climate of peace-making in the Middle East, it would be insufficient simply to identify problems: possible solutions should at least be hinted at. The following is a brief appraisal of issues that must be confronted if a riparian settlement is to be achieved.

It is important to stress, first and foremost, that the various aspects of the water crisis should be considered within a single formula. Specifically, an integrated solution must incorporate a balance between three elements:
1. Allocation of available water supplies.
2. Enhancement of existing supplies.
3. Conservation and appropriate utilization of water supplies.

Allocation of available water resources

Resolution of the Palestinian-Israeli allocation dispute will necessarily be governed by the principles of international law. Two legal aspects of the conflict concern us here. Firstly, Palestinians and Israelis must reach a consensus on sovereignty over water resources in the Occupied Palestinian Territories. And secondly, Palestinians and Israelis must reach agreement on each party's rightful allocation of shared water resources.

International law views the West Bank and Gaza Strip as occupied territories. As such, Israel does not have the right of sovereignty over the West Bank and Gaza; it merely exercises *de facto* authority. Neither does Israel have *de jure* sovereignty over natural resources such as water. Israel, in accordance with the demands of UN Security Council Resolutions 242 and 338, is obliged to end the occupation. The DOP specified that final status negotiations would be premised on these two resolutions. After the final settlement, therefore, Palestinians should acquire *de jure* and *de facto* sovereignty over the West Bank and Gaza Strip, including all natural resources.

As a corollary to the establishment of Palestinian sovereignty, Israel should recognize its occupation practices as violations of the Hague Regulations (1907) and the Fourth

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Geneva Convention (1949). Most importantly, Israel should admit that occupation practices have led to a deterioration of Palestinian water resources, and that this contravenes Article 53 of the Geneva Convention. Israel should assume responsibility for this possibly permanent degradation of water resources.

After Palestinian sovereignty has been agreed upon, Palestine and Israel must reach agreement on what the DOP (Annex III [1]) referred to as "the water rights of each party". Shared water resources - the River Jordan, the mountain aquifer and the coastal aquifer - must be allocated fairly, in accordance with international law. The Helsinki Rules (1966) provide the most comprehensive codification of international water law, listing a total of eleven relevant factors to be considered in the resolution of riparian conflicts, factors relating to geography and hydrology, to economic, social and demographic needs, to past and present utilization, and to alternative means of satisfying demand. Negotiations over allocation must be conducted with an eye for justice rather than might, and independent arbitration may be necessary.

Enhancement of existing supplies

Re-allocation, in itself, would be an insufficient means of averting conflict over water resources. A regional increase in supply relative to demand must be achieved - either through enhancing supplies or reducing demand, or through a combination of both approaches.

Resources could be enhanced through developing large-scale projects, involving the import of water. Water could be purchased from water-surplus states, and conveyed to the region through pipelines, canals, oil tankers, or even enormous balloon-like "medusa bags". Lebanon's Litani River, the Egyptian Nile, the Euphrates in Turkey, Yugoslavia and Norway have all been cited as potential sources of water. An alternative option involves desalination of Red Sea or Mediterranean waters - possibly in combination with hydro-electricity generation and the transfer of water to the shrinking Dead Sea. Such mega-projects could be highly problematic, however, on a number of levels:
*Economically. The cost of most of these proposals make them unfeasible, even given the payoff in water resources. For example, while a full study has yet to begin on the proposed Red Sea-Dead Sea Canal project, a preliminary estimate of $3 billion has been made just for construction, with further costs for piping desalinized water from source to consumer.
*Environmentally. Exporting substantial amounts of water from a river or basin may have harmful ecological repercussions. The transfer of water into the Dead Sea could aggravate the salinization of Jordan Valley aquifers.
*Politically. Exporting water from another country would involve sacrificing water independence, and the much-vaunted concept of "water security". While an increased supply of water among the Jordan basin states would no doubt lessen tension between Israel, Palestine and Jordan, tension would become more fraught among the riparians of

the donor waters: the development of a Turkish "peace pipeline", for instance, would increase tension between Turkey, Syria and Iraq.

Because of these potential difficulties, it may be wiser to focus on enhancing supplies internally. Simple, small-scale enhancement measures take advantage of the fact that 75% of rainfall is lost through evaporation. Employed throughout the region, they could significantly increase supplies. Rooftop rainwater harvesting, for instance, a method currently used in a quarter of West Bank houses, could supply 22 mcmy in the West Bank alone. The collection of rainwater run-off from agricultural plastic sheeting could enhance water supplies by an additional 4 mcmy. The harvesting of water through small-scale dams and terraces in wadis could also be expanded. Wastewater treatment, if comprehensive, can lead to the recycling of 70% of domestic wastewater: hence, even at the present minimal level of domestic consumption, wastewater treatment could yield 55 mcmy of water for irrigation in Palestine. Yet more water could be made available for irrigation through the mixing of saline with fresh water (Isaac et al 1994b). Whether such modest projects would sufficiently enhance supply is questionable, however: certainly they would only do so if accompanied by an increased stress on conservation and appropriate consumption.

Conservation and appropriate utilization of water supplies

A large proportion of the region's water supplies are wasted, through the age and inefficiency of supply and irrigation systems, and through inappropriate economic practices. The Palestinian water authorities, for instance, report losses as high as 40%. Within agriculture, simple surface methods of irrigation are highly inefficient, requiring double the amount of drip irrigation systems to irrigate the same area. Improving water supply systems and irrigation technologies is vital.

The introduction of improved crop varieties and more water efficient crops would be a further step toward optimizing available water resources. Rainfed farming should also be developed. The region's drylands, given appropriate management, could become more productive: this would render a shift away from irrigated to dryland farming feasible. Rainfed lands currently account for 95% of the West Bank's cultivated area, and this could serve as an example to other states.

Conservation could be further engendered through the real cost of water being charged, most Middle Eastern water being highly subsidized at present. Additionally, Middle Eastern states should be asking themselves whether the emphasis they place on agriculture constitutes an economic burden, and a profligate use of precious water resources.

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Conclusion

The recent Israeli-Jordanian rapprochement included agreement on rights to the Jordan and Yarmouk Rivers, paying no heed to Palestinian rights to these waters. The Peace Treaty represents a further denial of Palestinian water needs, and only exacerbates Palestinian fears that their minimal water requirements will remain unmet.

The Palestinian-Israeli water dispute could be resolved, however - but only if the issues of water allocation, water supply and water conservation are addressed as an interrelated whole. All party's rights, needs and interests must be met: if they are not, any settlement will prove to be unsustainable. And first and foremost in terms of rights, needs and interests must come Palestine, where water availability fails to meet the minimal requirements necessary for social and economic well-being.

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Table 1. Surface Waters of the Jordan River Basin[a]

Source or body of water	Average flow (mcmy)
Hasbani River	157
Dan River	258
Banias River	157
Upper Jordan River	640
Jordan River outlet from Lake Tiberias	538
Yarmouk River near confluence with River Jordan	475
Wadis on east side of Jordan River below Lake Tiberias	123
Wadis on west side of Jordan River below Lake Tiberias	145
Jordan River at Allenby Bridge	1250

[a]These figures are for average annual measured flow in 1953, prior to the development of Israel's National Water Carrier, the drainage of Lake Huleh, and other large-scale water projects. Current flow is considerably different. These figures therefore represent natural flow. It should also be noted that underground water source flows are not included here.

Source: Main 1953.

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Table 2. Control of West Bank Aquifers, Various Estimates

Basin	Palestinian allocation (mcmy)			Israeli allocation (mcmy)[d]			Total capacity (mcmy)		
	Z&I[a]	S[b]	W[c]	Z&I	S	W	Z&I	S	W
Western	25	27	20	310	323	300	335	350	320
Northeastern	30	25	20	110	106	120	140	131	140
Eastern	60	58	50	65	35	75	125	151[e]	125
Total	115	110	90	485	463	495	600	632	585

[a]Zarour and Isaac 1991. [b]Shuval 1993. [c]Wolf 1993. [d]includes settlers. [e]includes 58 mcmy of brackish water that Shuval estimates to be unused.

Sources: Shuval 1993; Wolf 1993; Zarour and Isaac 1991.

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Table 3. Total and Per Capita Consumption in Israel and Palestine[a]

	Israel/Palestine		West Bank		Gaza	
	Israel	Pals.[b]	Settlers	Pals.	Settlers	Pals.
Total consumption (mcmy)	1700	219	65	123	6	96
Population (millions)	4.6	2.0375	0.1[c]	1.3265	0.0035	0.711
Per capita consumption (cmy)	370	107	650	93	1714	135

[a]all figures for 1990. [b]excludes settlers in the West Bank and Gaza. [c]excludes the 150,000 Israeli settlers in occupied East Jerusalem.

Sources: Gleick 1993; Isaac et al 1994a; Peace Now 1993.

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Table 4. Sectoral Water Consumption in Israel and Palestine

Sector	Israel		Palestine	
	Total (mcm)	% of total	Total (mcm)	% of total
Domestic	340	20	78	35
Industrial	85	5	7	3
Agricultural	1275	75	140	62
Total	1700	100	225	100

Sources: Gleick 1993; Isaac et al 1994a; Zarour and Isaac 1991.

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Table 5. Agriculture in Israel and Palestine

	Israel	Palestine
Contribution to GDP by agricultural sector (%)	6	23-29[a]
Employment in agriculture (as % of total employment)	3.5	26.3[b]
Cultivated land that is irrigated (%)	47	6
Total water consumption (mcm)	1700	225
Agricultual water use (as % of total consumption)	75	62
Total annual quantity of water used for irrigation (mcm)	1275	140
1990 population (millions)	4.5596	2.0375
Per capita annual quantity of water used for irrigation (cm)	280	69

[a]the 1st figure is for the West Bank, the 2nd for Gaza. [b]excludes Palestinians working in Israel.

Sources: Central Bureau of Statistics various issues; Eckstein et al 1993; Gleick 1993; Isaac et al 1994a; Zarour and Isaac 1991; Zarour and Isaac 1993.

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Table 6. Population Growth Projections for Israel and Palestine

Year	Israel	Gaza	West Bank	Palestine
1990	4,559,600	711,000	1,326,500	2,037,500
2000	6,023,200	1,162,500	2,289,400	3,451,900
2010	6,695,200	1,639,900	3,137,000	4,776,900
2020	7,457,200	2,203,900	4,015,600	6,219,500

Sources: Central Bureau of Statistics various issues; Eckstein and Fishelson 1994; Isaac et al 1994a.

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Table 7. Projected Sectoral Demand for Palestine

Year	Domestic	Agricultural	Industrial	Total
1990	78	140	7	225
2000	263	217	18	497
2010	484	305	37	826
2020	787	415	61	1263

Source: Isaac et al, 1994a.

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Captions to Figures

Figure 1. The Topography of Palestine (m).

Source: ARIJ.

Figure 2. Rainfall Histogram for Hebron and Tulkarem, 1991 and 1992 (mm).

Source: ARIJ.

Figure 3. Rainfall Map for Palestine (mm).

Source: ARIJ.

Figure 4. The Jordan International River Basin.

Source: ARIJ.

Figure 5. Sources and Consumers of Jordan River Waters (mcm).

Source: modified after USIS.