2 Squeezed Dry: the Historical Trajectory of the Lower Jordan River Basin

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Introduction

The lower Jordan River basin (LJRB) provides a fascinating tale of coupled social and environmental transformations of a waterscape. In this semi-arid to desert area, water is an essential determinant of life, cultural values, social structures, economic activities, power and politics. The trajectory of this basin from a nomadic agro-pastoral Bedouin culture to an urbanized region where water circulation is highly artificial, illustrates how a particular resource endowment is valued, mobilized, shared, used and fought for.

This chapter first recounts past water resource development in the LJRB – defined as the Jordanian part of the Jordan River basin, downstream of Lake Tiberius – and dwells on the specific relationships between water, local culture and national/regional politics. The historical evolution of supply and demand is then expressed in terms of water balances that quantify the degree of closure of the basin.[1] Water challenges and response options are then addressed through the lens of the distribution of the benefits and costs they entail, and of their linkages with the current distribution of decision making and political power. Basin closure induces increased interconnectedness between water users and ecosystems through an increasingly manipulated water cycle: response options are interdependent and reveal the political and contested nature of resource sharing and water management (Molle *et al.*, 2007). This chapter describes how these processes, constrained by the drastic natural conditions of the basin, unfolded since the late 1950s and explores possible futures.

Features of the Lower Jordan River Basin

The Jordan River is an international river which drains a total area of about 18,000 km². Its three headwater tributaries originate in Lebanon and Syria and flow into Lake Tiberius, a freshwater reservoir now used almost exclusively by Israel (Fig. 2.1). The Jordan River then flows southward before discharging into the Dead Sea.

Ten kilometres downstream of Lake Tiberius, the lower Jordan River receives water from its main tributary, the Yarmouk River, which originates in Syria. The Zarqa River and several temporary streams of lesser importance, named side-wadis, come from the two mountainous banks and feed the lower Jordan River (Fig. 2.1). Prior to water development projects, the original flow of the Jordan River into the Dead Sea varied between 1100 and 1400 Mm^3/year (El-Nasser, 1998; Klein, 1998; Al-Weshah, 2000).

Fig. 2.1. The lower Jordan River basin in Jordan.

This chapter focuses on the LJRB and does not dwell on the geopolitical issues related to water sharing between the riparian states of the Jordan River (Lebanon, Syria, Israel, Jordan). The Yarmouk River and the upper Jordan are thus considered as contributing inflow to this basin. Moreover, the other streams draining to the Dead Sea from the south and from Israel are also not analysed.

The LJRB represents 40% of the entire Jordan River basin but only 7.8% of the Jordanian territory (cf. Fig. 2.1). The basin so defined is nevertheless the wettest area in Jordan, is home to 83% of the population, supplies 80% of the national water resources, and encompasses most irrigated areas. The basin, like the country, is divided into two main areas (see Fig. 2.2):

- The Jordan valley is a 110 km stretch between the Yarmouk River in the north and the Dead Sea in the south. Its altitude varies from 200 m (in the north) to 400 m below sea level (in the south). The valley can be considered as a natural greenhouse, with moderate temperatures during winter and high records during summer, commonly exceeding 45 °C. Rainfall ranges from 350 mm/year in the north to 50 mm/year near the Dead Sea (Fig. 2.3). The Jordan River flows in a 30–60 m deep gorge through a 0.2–2 km wide fertile alluvial plain, locally called *Al Zhor* (Fig. 2.2). The rest of the valley, *Al Ghor*, is a 4–20 km wide area with deep and fertile colluviums.
- The highlands comprise a mountain range running alongside the Jordan valley (named

Uplands hereafter) and a *badia* (desert plateau) extending eastwards to Syria and Iraq (Fig. 2.2). About 30 km wide, with an altitude reaching 1000 m above sea level, these mountains receive around 400–600 mm of rain per year, while snowfall can also be observed during winter (Fig. 2.3). Historically, they were covered with forests (essentially composed of Mediterranean conifers), but are now mostly composed of rangelands with olive trees and stone-fruit trees.

The eastern plateau has an average altitude of 600 m, and rainfed cereals are grown near the mountains, in the area where rainfall is still sufficient and where main urban agglomerations (Amman, Irbid, Al-Baq'ah, Jerash, Ajloun) are concentrated. Eastward, precipitation becomes scarcer (between 200 and 300 mm/year), and only nomadic livestock farming and some groundwater-irrigated farms can be found.

Total precipitation in the LJRB is estimated at 2235 Mm^3. In crude terms, 88% of this precipitation is directly evaporated (40% of this evaporation being beneficial, i.e. consumed by irrigated and rainfed crops or domestic and industrial uses), 5% flows into the rivers, and the remaining 7% infiltrates to recharge the aquifers (and is then pumped to meet human demands).

The flow at Lake Tiberius, which averaged 605 Mm^3/year before the 1950s (Klein, 1998),

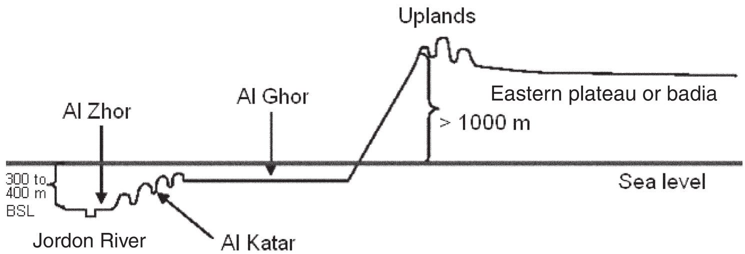

Fig. 2.2. Topography of the laver Jordan River basin in Jordan.

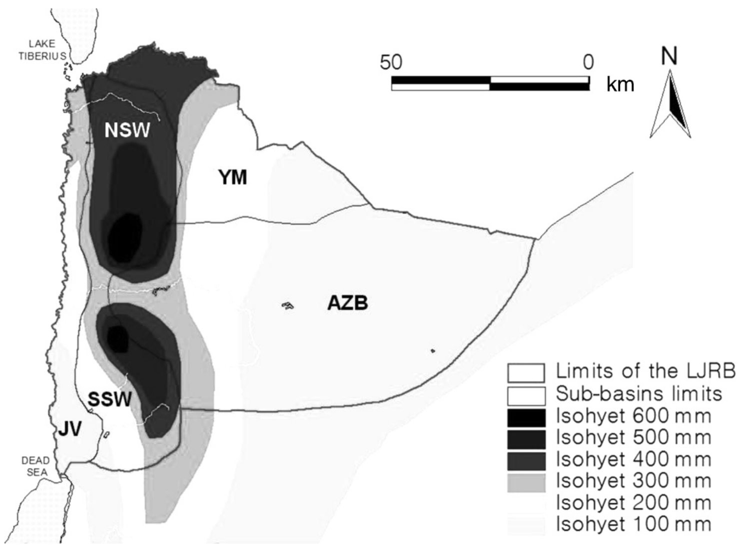

Fig. 2.3. Average rainfall distribution in the LJRB.[2]

is now diverted by Israel to its National Water Carrier. The Yarmouk River is thus the main source of surface water: its flow averaged 470 Mm^3/year in the 1950s (Salameh, 1993), while the side-wadis and the Zarqa River originally contributed 120 and 90 Mm^3/year, respectively (Baker and Harza, 1955).

The main aquifers closely dovetail with the five main sub-basins (Fig. 2.3): the Yarmouk basin (YM), which drains northward to the Yarmouk River; the Zarqa basin (AZB), which drains most of the *badia* towards the valley; the northern and southern side-wadi basins (NSW and SSW, respectively), which pool lateral wadis north and south of the Zarqa River; and the Jordan valley (JV) itself. Annual recharge of the aquifers is estimated at 155–160 Mm^3/year (THKJ, 2004).

A Chronology of Water Resources Development

Ancient settlements and early land development

The lower Jordan River basin is at the heart of historical transformations in the Middle East, due to its central position 'as a land bridge for animals and humans between Africa and Eurasia; a Levantine corridor, a transit route for large and small migrant groups but also an area pinned between powerful states: Egypt to one side, Northern Syria/Mesopotamia to the other' (van der Koij and Ibrahim, 1990: 14).

Large settlements like Ain Ghazal (near today's Amman) are associated with the Neolithic period (c.8000–6000 BC). In this period, plants and animals (sheep, goats, cattle, pigs) were domesticated. Rainfed farming of wheat, barley and legumes expanded later, in the fourth millennium BC, to lentils, bitter vetch, sesame, olives, flax, dates and grapes. Rock basins and pools collecting natural water were utilized for storage for domestic and agricultural uses (Lancaster, 1999).

Later, 900–300 BC was a flourishing period for the Arabic kingdoms and a peaceful time in the LJRB. The first urban settlements were established in this era. The Nabataeans moved from the Arabian Peninsula into southern Jordan, where they established themselves in the eastern steppe and, with the help of ingenious hydraulic infrastructures, were able to farm the land at Petra while maintaining important trading activities. After the conquest of the region by the Romans, the economy came to rely on a flourishing irrigated agriculture, trade and Christian pilgrimages (Lancaster, 1999).

Through ups and downs, the region witnessed the Islamic conquest, the Ummayads, the Abbasids, the Crusades, the Ayyubid–Mamluk era (1187–1516) and the Ottoman conquest in 1516. The Jordan valley reached the peak of its agricultural development during the first period of the Mamluks (14–15th century). Irrigation developed wherever possible, and sugar mills, powered by water, were built in many spots in the valley. The Ottoman administration period, in contrast, was characterized by instability and depopulation in both the valley and the highlands. In 1956, the population of the east bank of the Jordan River (Transjordan) was estimated at 52,000 (Abujaber, 1988).

In Western travel accounts of the 19th century, the Jordan valley appears as a wild and dangerous place (with the threat of malaria and the fear of attack and robbery by Bedouin tribes) but, at the same time, as a biblical region with impressive, exotic scenery. The valley was a large grazing ground and an important region intersecting the tribal land of several Bedouin tribes. Up to World War II, surface irrigation was practised along the wadi valleys and, most prominently, at the point where wadis formed alluvial fans in the Jordan valley (Lancaster, 1999; Suleiman, 2004). Management was communal, under the authority of the tribes' sheikh, but coexisted with forms of private ownership of land and even of collective ownership of spring water and well water (Shryock, 1997).

The first planning interventions: 1921–1973

Transjordan was placed under temporary British administration (*Mandate*) in 1921 and became fully independent in 1946, as the Hashemite Kingdom of Jordan (THKJ). The British initiated cadastral registration of land titles and fiscal surveys from 1929 onward, demarcating village boundaries, state domains and forests in agricultural lands. The mandate period allowed Zionist projects, also based on irrigation schemes, to expand on the east bank of the Jordan River (the East Bank), making this region a security area (Goichon, 1967). Moneylenders and merchant families increased their investments in agriculture and their ownership of land, forming the basis for later capital investments in agriculture, in parallel with the decreasing power of the Bedouin tribes.

As one of the regions with the highest potential for agricultural expansion, the Jordan valley has been the object of numerous hydraulic and agricultural feasibility studies since the end of the 19th century. For foreign experts the valley was a symbol of high productivity wasted for lack of attention, which thus required urgent external intervention, prompting Merril (1881: 139) to declare that 'The American farmer would look with envious eyes upon the fertile portions of this valley.' Projects were fuelled by technical optimism and by a new ideology of irrigation as a transfer of resources and expertise from outside that would solve the problems of a local population depicted as 'conservative, ignorant, wretchedly poor, unable to contend with the forces of nature' (Gottman, 1937: 556).

In 1948, following the creation of Israel, 774,000 Palestinians were displaced (UN, 1949), of whom 70,000–110,000 escaped directly to the East Bank, which at the time had an indigenous population of about 440,000 (Brand, 1995). Refugee displacement in 1948 added to the urgency of developing irrigation: the resettlement programme in the Jordan valley was highly influenced by USAID and the International Bank for Reconstruction and Development (later the World Bank) and inspired by the 'integrated development' scheme of the Tennessee Valley Authority (TVA) in the USA, the icon of large-scale hydraulic planning projects (Molle, 2006). This model of development clashed with previous British foreign policies in the Middle East focused on the development of agricultural cooperation. British interventions favoured small-scale projects built on local indigenous expertise that could bypass the regional political gridlock regarding the use of water resources in the Jordan basin (Kingston, 1996). By the mid-1950s the Jordanian Division of Irrigation had completed dams on several of the eastern wadis draining to the Jordan River (except the southernmost wadi Shu'ayb and the larger Zarqa River), boosting irrigation in the Jordan valley (Kingston, 1996).

Already, in the 1930s, the first wells were dug in the highlands and water was pumped from Azraq (an oasis in the desert located about 150 km east of Amman, outside the LJRB) (Lancaster, 1999). Significant exploitation of groundwater started in the 1950s and 1960s, with the introduction of diesel motor pumps. Several international organizations (UNESCO, FAO, ILO) launched or promoted sedentarization programmes for Bedouin tribes, which included plans for developing irrigated agriculture and settlements, viewed as an essential step to economic integration, 'modernization, stability in the region and control of rangeland (the *badia*)' (Bocco, 2006). The area irrigated with groundwater gradually increased and was multiplied fourfold between 1965 and 1980. Government licences and soft loans for drilling private wells led to a frontier 'moving ever eastward into an increasingly ecologically and economically marginal environment' (Millington *et al.*, 1999).

The introduction of tractors, water tanks and water pumps during the 1950s induced crucial changes in water management. The Jordan valley was home to various systems of irrigation (wadis, diversions, canals, reservoirs, springs, pumps) and multiple actors were involved (such as the United Nations Relief and Works Agency for Palestinian refugees (UNRWA), the Jordanian state, British consultants, the World Bank, USAID). The construction of the East Ghor canal, which was to distribute water diverted from the Yarmouk all along the East Bank, started in 1957, but was halted several times due to warfare. The first 69 km were completed in 1966. Between June and September 1967, 395,000 Palestinians crossed the Jordan River, due to the occupation of their land by Israel. Israel occupied the West Bank, and the Jordan valley became for some years a battleground between Palestinian fighters and Israel and, in 1970, between Palestinian fighters and the Jordanian army. The extension of the canal to the south resumed after 1971. Irrigated agriculture developed on a large scale (13,500 ha) through the

East Ghor concrete canal (later renamed King Abdullah canal, or KAC), in parallel with a land reform (1962), and several projects of urbanization and settlements (Courcier *et al.*, 2005).

The development phase: 1973–1995

In 1977, the Ministry of Water and Irrigation (MWI) published a global assessment of water resources in Jordan (THKJ, 1977). A first harsh reality was the dramatic loss of the upper Jordan water to Israel: the inflow to the LJRB had decreased from 605 to 70 Mm^3/year (Klein, 1998). Because of the combined water uses in Israel, Syria and Jordan, only 40% (505 Mm^3/year) of the historical flow of the Jordan River still reached the Dead Sea in 1975 (Courcier *et al.*, 2005).

The exploitation of water resources further increased between 1975 and 1995. In the Jordan valley, irrigated agriculture was expanded through the construction of several hydraulic facilities: extension of the KAC (with 3400 ha of land newly irrigated), installation of pressurized water distribution networks, storage dams on the Zarqa River and other side-wadis. In the early 2000s, past investments in the water sector in Jordan, mainly financed by international aid, were estimated to total US$1500 million (Nachbaur, 2004; Suleiman, 2004). With new techniques of production (greenhouses, drip irrigation, plastic mulch, fertilizer, new varieties, etc.), the availability of Egyptian force and market opportunities (at least until the first Gulf War), irrigated agriculture in the Jordan valley enjoyed a boom in production and economic profitability, described by Elmusa (1994) as the 'Super Green Revolution'. The particular climate of the Jordan valley allows many small entrepreneurial farmers to produce vegetables almost all year round (and especially during winter), as well as some fruits that can withstand heat in summer (citrus and bananas).

In the highlands, private wells provided unlimited access to good-quality groundwater. Wealthy and dynamic entrepreneurs (of both Transjordanian and Palestinian origin), emulating or replacing past Bedouin or peasant (*fellahin*) settlements, made massive investments and developed an irrigated agriculture which supplied Jordan and the Gulf countries with fruits and vegetables during summer.

During the same 1975–2000 period, the urban population within the basin was multiplied by roughly 2.5 (DoS, 1978–2003), with urban groundwater use consequently growing fivefold to reach 150 Mm^3/year (records of the MWI–Water Resources Department). This demand was met by both increasing the number of wells in the surroundings of the cities and transferring more groundwater from distant areas and surface water from the KAC to urban areas in the highlands (Darmane, 2004). This latter transfer, initiated at the end of the 1980s, was expanded after the massive inflow of Jordanian-Palestinians returning to Jordan after the first Gulf War (1991) and is now the main source of water for Amman (almost 100 Mm^3/year by 2008). This transfer was made possible because of the concomitant treatment of wastewater from Amman: effluents are collected in the King Talal reservoir (built between 1971 and 1977 on the Zarqa River) and mixed with freshwater, and this blended water is then used to irrigate the middle and the south of the Jordan valley.

Further reduction in the water coming from the Yarmouk and reaching the LJRB was observed after the late 1970s. During the 1980s, water use doubled in Syria, with 35 middle-size dams built in the upper Yarmouk basin and direct pumping from rivers and wells (El-Nasser, 1998). In the early 2000s, the Yarmouk contributed 270 Mm^3/year to the Jordan River (THKJ, 2004), of which about 110 Mm^3/year flowed uncontrolled to the lower Jordan River until the recent completion of the Wehdah dam (2007). The peace treaty signed between Jordan and Israel in 1994 also specified that the 25 Mm^3 pumped each winter by Israel from the Yarmouk would be returned to the KAC during the year, an agreement loosely implemented so far and which does not consider issues of water quality. With all these changes, the inflow to the Dead Sea was reduced to less than 20% of the historical flow of the Jordan River, resulting in a drop of its water level by 20 m since the late 1950s, showing a dramatic degradation of the environment of the entire Jordan River system (Orthofer *et al.*, 2007) and threatening the local tourist industry.

1995 onward: the rise of the water challenge in Jordan

In the 1990s, water rose to the top of the nation's political agenda. Concerns shifted from refugees in the 1950s, towards land management in the 1970s, and finally water in the 1990s. In 1997, the Jordanian government adopted a new Water Strategy Policy (THKJ, MWI, 1997), setting allocation priorities to the urban sector, then to the industrial and tourist sector, and finally to the agriculture sector: policy reforms aimed at meeting the challenges faced by the country.

Physical scarcity of water resources is an obvious challenge, compounded by rapid population growth. The rapid increase in water needs is due to an improvement in living standards and to a high demographic growth of 2.9%, notably in urban areas (nearly 80% of the population is concentrated in cities) (DoS, 2003). Migration, in particular the sudden waves of Palestinian refugees in 1948 and 1967, has had a major impact on water use in the country. So did the wave of around 300,000 people of Palestinian origin who had to return to Jordan from Kuwait after the Gulf War of 1990–1991, 95% of whom resettled in the LJRB area (de Bel-Air, 2002). The recent migration of Iraqis escaping from the embargo and the war – estimated at 1,300,000 – is now a major challenge for the country.

Groundwater overuse causes degradation of the groundwater resources, both in the short term (direct pollution due to infiltration of pesticides and fertilizers: see JICA, 2004) and in the long term (salinization of groundwater due to a drop of water tables: ARD and USAID, 2001; Chebaane *et al.*, 2004). Overabstraction has also led to the drying of springs and, in particular, to the disappearance of the Azraq oasis, a Ramsar wetland. The measures taken to abate groundwater use for agriculture from private wells in the highlands have been unsuccessful. Abstraction limits have never been respected and too many licences have been issued. The Groundwater Control Bylaw No. 85, passed in 2002 and further amended in 2004, was designed to regulate groundwater abstraction through the establishment of a quota of 150,000 m^3 per year per well and a block tariff system for any use beyond that quota. However, this quota is much higher than the limits mentioned in the original well licences. It was reported that farmer interest groups obtained the cancelling of the former lower limits against the acceptance of the principle of taxing volumes abstracted above a higher limit (Pitman, 2004). Upper (optimistic) estimates of the reduction in gross water abstraction due to the bylaw point to a potential decrease of 4%, i.e. 5.5 Mm^3/year, a drop in an ocean of overabstraction and quite short of the 40–50 Mm^3 hoped for (Venot and Molle, 2008).

Water management challenges in the basin are linked not only to the expansion of Amman but also to the process of suburbanization of the countryside around the capital, near Irbid and in the *badia* (Lavergne, 1996). Farms have become secondary residences, new villas have increased land fragmentation, and the habitat in the highlands countryside gradually resembles that of Amman. A similar dynamic can be observed in the Jordan valley, where fenced fruit orchards often hide a villa – and sometimes a swimming pool – used at weekends and where the value of prestige and status is higher than the economic productivity of the farm itself.

Urban development and the lack of untapped resources have led to a policy of transferring increasing volumes of freshwater from irrigated agriculture to urban uses, thus affecting the stability of the agriculture sector. During dry years, 2000–2002 for example, the Jordanian government froze the quantity of water reserved for cities, while drastically reducing the amount allocated to agriculture in the Jordan valley. This reallocation from the Jordan valley to the highlands has been partly compensated for by an ever-increasing supply of treated wastewater (TWW) to the south of the valley (McCornick *et al.*, 2002; THKJ, MWI, WAJ, 2004). The hazards associated with a generalized use of TWW in agriculture remain poorly known and include workers' and consumers' contamination, soil degradation, clogging up of irrigation system emitters, disappearance of certain sensitive crops (strawberries, beans, citrus, etc.), consumers' lack of confidence in the quality of the products, drop in prices and loss of some export markets (Grattan, 2001; McCornick *et al.*, 2002). In the Jordan valley, there is also growing evidence of water pollution by nitrates and soil degradation (Orthofer, 2001).

Water conservation and the quest for greater end-use efficiency have also spurred several policies and measures in the urban and irrigation sectors. These include, for example, modernization and physical improvement of urban distribution networks, reduction of the volumes of water unaccounted for, and transfer of Amman's water supply and wastewater collection to a private company (Darmane, 2004).[3] In the Jordan valley, measures include completing the conversion from the earlier gravity network to pressurized systems, incentives to adopt micro-irrigation at the plot level, reduction of per hectare quotas, and increases in the cost of water to farmers. At a collective level, a German cooperation programme (GTZ) supported efforts at building up the first water-user associations in the Jordan valley.

Most of these policies have met with limited success. In the Jordan valley, quotas are low and farmers use their full allowance in all conditions: technical interventions improve irrigation efficiency not because water use is reduced but because better uniformity and timing of water application enhance crop evapotranspiration and yields (Molle *et al.*, 2008). Agricultural water prices in the Jordan valley have been raised several times but with negligible impact on water demand (World Bank, 2003; Molle *et al.*, 2008), especially for high-value fruits and vegetables. If prices were further raised they would substantially dent the net revenue of citrus and banana farmers and encourage/force them to reconsider the benefits, risks and constraints of adopting new crops and technologies. The poorest vegetable farmers would be bankrupt, at the risk of high social and political consequences. Quotas appear to be the only straightforward measure for reducing diversions. The 1997–1999 period was marked by a severe drought, which forced reductions in allocation, which were extended from 1999 to 2003, although adjusted each year, and made permanent in 2004. At a regional scale, this generated total freshwater savings of about 20.2 Mm^3/year, reallocated to domestic use in Amman.

Another important and sensitive issue is the operation and maintenance (O&M) costs of infrastructure. Until now, for both urban and irrigation supply, emphasis has been placed on obtaining international funding for implementing modern systems rather than on O&M recurring costs. Degradation and fiscal austerity call for better coverage of these costs. The increase in water tariffs in the Jordan valley has allowed two-thirds of O&M costs to be recovered, and studies show that full O&M cost recovery is achievable and commensurate with farmers' income (Molle *et al.*, 2008).

The future of irrigated agriculture raises a complex set of social, economic and political questions that largely lie outside of the water sector itself. The two major issues are the treatment of prestige agriculture and the question of economic sustainability. Irrigated agriculture in the highlands has mainly developed during the last three decades through large private investments: the investors concerned belong to high society (MPs, senators, entrepreneurs, sheikhs, etc.). Their social importance and their influence on government decisions suggest that all the measures aiming at reducing their water use will be conflict prone and will take a long time to implement. While part of this agriculture is highly capital intensive and profitable, around 30% of irrigation water is used in low-value olive-tree farms. These orchards, are a legacy of a time when the drilling of wells was subsidized, and are held for reasons of prestige, as a means of keeping ownership and control of land. Likewise, many citrus plantations in the Jordan valley are held by absentee owners (often urbanites) who are not interested in complex farm management, prefer low-return, extensive agriculture, and partly transform their farms into leisure places. Banana farms in the north of the valley are also linked to politically powerful tribes and partly thrive on higher water quotas and import barriers.

More generally, agriculture is facing declining profitability. Marketing constitutes the main problem that agricultural producers face (ASAL, 1994; World Bank, 1999). Jordanian irrigated agriculture mainly developed during a period (1975–1990) of strong regional demand for fresh products. Products could be sold at a high price because of the payment capacity of the Gulf countries and limited competition in the region. At that time, investments in agriculture (greenhouses, irrigation systems, wells, equipment, etc.) provided a handsome return within a few years and attracted many investors. After 1985, the quick development of production in Jordan and in the region (Syria, Lebanon, Gulf countries) led to a drop in prices and in the profitability of investments (Nachbaur, 2004). Moreover, the first Gulf war of 1991 worsened this situation, since the Gulf markets, which constituted a major outlet for Jordanian products, were lost (Jabarin, 2001) as a result of the Jordanian state's support of the invasion of Kuwait by Iraq. In addition, Jordan has favoured the development of new economic sectors (tourism, services, industry) and signed several agreements[4] which could undermine the profitability of certain agricultural products still protected in Jordan (e.g. bananas and apples). This situation could also reverberate on the country's trade balance. Fruits and vegetables and their export represent, on average, 12% of the value of Jordanian exports (THKJ, MoA, 2001), and any reduction in the production would raise macro-economic concerns.

Negative impacts would be passed on to the more vulnerable rural groups, notably low-income Jordanian categories (refugees, Jordanian tribes of low status, female labourers) and male migrants (two-thirds of whom come from Egypt).

Water, People and Politics

These socio-economic and technical aspects of water use in the country are closely linked to cultural and regional politics and to the changing relationships between Jordanian society and water.

The social fabric and changing perceptions of water

In the past, land and water were controlled by the *ashira* (tribe) represented by the *sheikh* (tribal leader) and were linked to the notion of *dirah*, which played a central role in resource management. The term dirah derives from *dar,* which literally means 'house', which may be a cement construction as much as a tent, and refers to the tribal territory, together with a system of exchange organized around the *khuwa* (the payment to tribes to obtain their protection). Access to resources was allowed to other tribes depending on demographic pressure, climatic conditions, resource scarcity and existing alliances. Thus, the border and the geographical extension of a dirah were often flexible but within perceptions of land that still persist nowadays (Bocco, 1987). This notion of territory is thus interlinked with indigenous ideas of resource property. As Lancaster (1999) showed, 'ownership comes through access, use, action and is validated by defence and reputation.' In fact, the notion of *ihya almawat* (vivification of land) through ameliorations and work, and not the ownership of land by itself, granted the rights and the control of land. This also applied to water resources since the ownership of water was a 'function of claims and access to resources, rather than a system of control and absolute right of disposal' (Lancaster, 1999).

The disruption of this tribal resource management in the last century and the displacement of Palestinians have transformed the units of belonging. Development institutions took charge of functions and responsibilities that were previously exercised by the tribe, such as management of land and water. Local agricultural and irrigation knowledge was displaced from the extended family and tribe to the experts and the administration. New international borders have severed pastoral routes, and the cement blockhouse has replaced the goat-wool tent. Bedouins have shifted from pastoralism to army employment, irrigated agriculture, outmigration, commercial and transport activities, or development administration.

Tribal political organization, forced displacement of Palestinians, labour migration, warfare in the Jordan valley, and intensive planning have shaped today's social structure and water projects. In this dynamic context, the developmental concept of a 'farmer community' has worked to unify, in one common category, communities who perceive themselves as diverse and are characterized by social heterogeneity and a diversified economy. The external representation of the heterogeneous population in the Jordan valley as a homogenous group of 'Jordanian farmers' within irrigation projects has definitely depoliticized a tense region and has been part of a wider process of incorporation into the nation. Through water development, new 'farmer settlements' have been set up. *Muzar'e* (farmer) is a category which can be understood only within the context of the new irrigated agribusiness developed in the LJRB: it refers to an occupational category within the new economic segmentation and differs from the traditional *fellahin* (peasant), who is understood as a wider moral and political belonging.

Modernization did not by itself mean the disappearance of tribal solidarity – on the contrary, it has readapted to new political and ecological environments. Bedouin values and tribal belonging have been mobilized and reproduced as part of a process of nation building within a demographic context marked by a large population of Palestinian origin (which fuelled a separate sense of belonging – inherent in the Palestinian national struggle), a contested border in the Jordan valley, and the Hashemite Kingdom's need for legitimacy in a tense environment. Tribal solidarity has often overlapped with the national administrative structure, shaping the new bureaucratic apparatus and national identity, and playing a central role as a form of patronage and a basis for affiliation (Brand, 1995). Therefore, 'tribal identity has become politicized as it continues to be the basic channel for allocation of resources by the central government' (Shami, 1982).

Other actors have been less visible. Since 1970, Egyptian migrants, together with minor groups of Syrian men and Pakistani families, have provided cheap labour to labour-intensive agricultural systems. Jordanian male wage labour in agriculture has nearly disappeared in recent decades, since men seek employment with better wages and less drudgery outside agriculture. This is counterbalanced by a feminization of agricultural labour, although notwithstanding the large number of women working as labourers today, the responsibility for irrigation has remained in the hands of men since it symbolizes the control over the wider production process (Shami and Taminiam, 1990).

The building of the state and regional geopolitics

In the past, periods of development and stagnation have often been related to the presence or absence of a strong authority that could offer security and protection to the Jordan valley (Khouri, 1981) and could allow a growing population to thrive. Periods of intense settlement have often been followed by periods with a sparse population, abandonment of agricultural settlements and insecurity.

In the Ottoman period (1516–1921) the state tried to establish firm control by introducing new concepts of land and water, supporting the immigration of agricultural settlers from the Caucasus, the setting up of a bureaucratic apparatus, the emergence of merchant elites in the agriculture sector (many from Syria or from Circassian, Chechen and Turcoman communities) and an increase in the export of agricultural products. Yet the communal patterns of resource management remained effective.

In 1933, the Land Settlement Law promulgated by the British administration opened the way to cadastral registration of land titles and to fiscal surveys. Agricultural development through irrigation projects for Bedouins was viewed by the British as the first step of a wider detribalization process that would help stabilize the country and settle 'new farmers to a neglected land' (Lowdermilk, 1944), as this area was erroneously portrayed, an essential step to economic integration, social emancipation and stability within nation construction.

At first instrumental in settling pastoral groups, water development would soon (after 1948) be aimed at resettling refugees. The development of water on the east bank of the Jordan valley in the 1950s led to the establishment of a new power structure and engendered a water bureaucracy, the Jordan Valley Authority (JVA). The tribal hierarchical system of distribution gave way to centralized planning of water, and high subsidies for irrigated water became a political tool, allowing state penetration in a crucial and unsettled rural area. Project implementation was characterized by a lack of participation and involvement of the local population, and the JVA introduced a new system of loyalty, through a centralized administration.

As de Bel-Air (2002) has shown, the state–citizen relationship has been intimately linked to the rentier nature of the Jordanian economy, based on an indirect rent (external aid from the Gulf States or the USA, remittances from migrants, etc.) and reproducing a clientelistic pattern of redistribution of resources, in which water is embedded. The structure of power has thus been linked to this redistribution of rents and to patronage: in this context, the economic value of agriculture, often criticized nowadays due to its large use of precious water and limited profitability, cannot be detached from the political and social meanings that agricultural development has acquired in Jordan, in terms of political stability, tribal and refugee settlement, and national incorporation of rural and arid areas.

Waterscape transformations and the new social environment

Today, irrigation in the LJRB has become an arena of struggle among different interest groups. In the Jordan valley, for example, the struggle between the extensive bureaucracy and its computerized distribution system, on the one hand, and the illegal methods reinvented daily by farmers to get access to water, on the other, express different and contrasting 'projects' with regard to water management. Centralized water management and the shift from surface irrigation to micro-irrigation and pressurized pipelines date back to the 1980s and have, in a very short time, radically changed the ways of thinking about and using water. This context of change is at the core of today's struggles and conflicts that arise around water at the local level. We face a situation of legal pluralism, with an overlapping of formal and informal water property rights systems and claims, in a context characterized by a lack of local participation and increasing water scarcity.

A first major change has been the transition from a water allocation based on the household head and tribal representatives to an allocation based on land use, controlled by a water administration vested with a new authority. This technical and bureaucratic presence has led to a wider process of secularization and materialization of, and disenchantment with, water (Hamlin, 2000): detached from the tribal community, water has become a technical affair, often artificially separated from its attendant social and cultural dimensions.

A second main consequence is the changed idea of water in relation to time. The water share was traditionally connected to an idea of a personalized and socialized time related to specific local ecological contexts and connected to the lineage system, where every part of the larger community received its time-share, which could be exchanged and adapted along social and neighbourhood relationships. With the establishment of a central bureaucracy, a new characterization of water in terms of quantity (cubic metres) and pressure of supply has been introduced.

Third, with state irrigation, a new idea of territory in relation to local communities has taken place. With drip irrigation and the introduction of pressurized collective networks during the 1990s, water has also gone underground and is not directly available or physically visible. Besides, water users in the LJRB are more and more hydraulically interconnected within pressurized systems covering larger areas than was the case when water flowed through traditional earthen canals.

Last, expert knowledge has become more important today than before in managing water since it has introduced a specific culture of organization and is linked to a resource management regime whereby, as Waller (1994) put it, 'water managers use their expertise to portray them [i.e. the changes] as technical rather than political decisions.' This is a major issue in the Jordan valley, where water management is described as an issue for experts, too complex for farmers to handle. This technical emphasis has both depoliticized the actual decisions made in relation to water and neutralized wider public debate on water issues in Jordan.

The Lower Jordan River Basin at the Crossroads

Embedded in a society in the making, with Bedouins, peasants, Palestinian refugees and foreign powers fused in a chaotic regional setting, water is a guiding element of historical transformations. Its importance in the future may even increase, as Jordan's scarce water resources cannot keep up with needs and immigration. This section first dwells on historical changes in land use and in the components of the water balance, giving a detailed account of the water flows in 2000, before expanding on the different solutions at hand.

Basin closure and the water squeeze

Changes in land use

The first notable evolution since the late 1950s is that of land use. Rainfed cropping areas significantly increased in the 1950–1975 period, with cereals providing work and food to a growing population (Fig. 2.4). This extensive type of agriculture later declined, with a shift in the economy towards non-agricultural activities. Irrigated olive-tree orchards in the highlands dramatically increased, from 420 ha in 1950 to 11,000 ha in 2000, i.e. making up close to half of the irrigated areas in the highlands (the other half consisting of vegetables and stone-fruit trees) (Courcier *et al.*, 2005). Figure 2.4 highlights the structural differences between the Jordan valley and the highlands: cultivated areas are much larger in the highlands (a total area of 143,900 ha in 1950) than in the valley (32,300 ha), which reflects the large areas of rainfed cereals and olive trees planted in the former. Irrigated areas increased from around 10,200 ha in 1950 to 45,800 ha in 2000.

Water accounting in 2000

The description of the transformation of the LJRB given in the preceding sections can be paralleled by a more quantitative accounting of the resulting (im)balance between water supply and demand. The net inflow to the LJRB includes rainfall, interbasin transfers, and possible net overdraft of the aquifers and reservoirs. This total inflow is partly transformed through evapotranspiration of crops (irrigated, rainfed and also natural vegetation) and evaporation from water bodies, and through municipal and industrial (M&I) processes. The balance flows to the Dead Sea, considered as a sink since maintaining its level is not considered as a management objective.

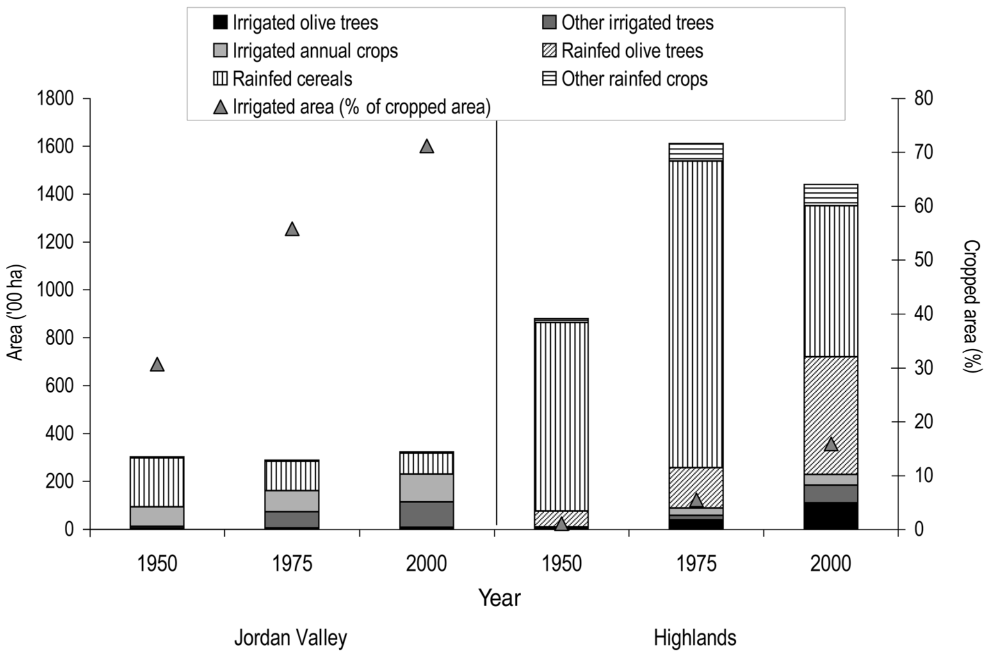

Fig. 2.4. Crop- and region-wise evolution of cropped areas in the LJRB since 1950.

Water is depleted, or consumed, by four generic processes: evaporation, flows to sinks (e.g. a saline aquifer), pollution and incorporation into a product (e.g. plant tissues) (Molden, 1997). In 2000, the LJRB consumed 86% of its net inflow through the above processes. About a third of the remaining outflow to the Dead Sea was coming from uncontrolled Yarmouk water (Courcier *et al.*, 2005), which is now partly stored in the Wehdah dam. *Beneficial depletion* (evapotranspiration from irrigation, rainfed agriculture, and M&I uses) accounted for 33.5% of the net inflow, *low beneficial depletion* (evapotranspiration from natural vegetation and forest) for 14.5% and *non-beneficial depletion* (evaporation from bare land, deserts and water bodies) for the remaining 38% (2% of the net inflow was exported to other basins and 12% as runoff). In the LJRB, irrigation accounts for 18% of the total depleted fraction. Data also indicate that despite all the allocation conflicts between the cities and agriculture, the share of M&I depletion is negligible, representing only 3% of the total depleted fraction in the LJRB. This share, however, rises to 16% when compared with the amount of water depleted by irrigation, and to 10% when expressed in terms of withdrawals.

These basin-level figures prompt some remarks on the question of efficiency in water use. Groundwater-based irrigation efficiency in the highlands has increased in the last two decades, with an almost complete shift from surface water irrigation to micro-irrigation (Elmusa, 1994; THKJ, 2004). In many cases, farmers continued pumping the same amount of water and have expanded their irrigated area (Venot and Molle, 2008). This not only increased farmers' incomes but also resulted in higher evapotranspiration and lower return flow to the aquifer, thus compounding the net overdraft. There is evidence that percolation losses from irrigation in the highlands return to the aquifer (JICA, 2001) and therefore do not affect the net water balance significantly (although pumping costs and the low quality of return flows are issues). Areas irrigated by diversion of wadis along the main valleys also have high efficiencies because return flows are quickly reintegrated to the main stream. In the valley, the shift to micro-irrigation owes more to the intensification of agriculture than to water scarcity per se, since it started 15 years before talks of a water crisis emerged. Cultivation of vegetables under plastic mulch that controls weeds makes micro-irrigation necessary and also allows better application of water and nutrients (*fertigation*). Other more extensive crops (notably citrus) as well as part of the banana crop are still irrigated by gravity, but the defined JVA quotas keep application losses to a minimum since quotas are less than full crop requirements in months when the overall demand exceeds supply.

Water balances can also be expressed vis-à-vis the *controlled renewable blue water* (CRBW), i.e. the sum of surface water, aquifer recharge and imports from both distant aquifers and surface water, from which have been deducted the (few) resources which cannot be controlled and are of 'no use': a few flash floods exceeding the capacity of the dams[5] as well as brackish flows from Israel. The overall water use in the basin, considered as a system, has continuously increased, with depleted withdrawals accounting for 11% of the CRBW in 1950, for 37% in 1975, and for 87% in 2000 (Courcier *et al.*, 2005).[6] The LJRB is a closed river basin, where little water is left to be mobilized and used. This sets a drastic limit to what can be achieved through conservation means (see next section).

Evolution of the terms of the water balance in the lower Jordan River basin

From the situation in the 1950s, when few of the surface water and groundwater resources were used, to the current situation of overexploitation, the terms of the water balance have obviously varied from one extreme to the other. The net inflow into the basin moved from over 3300 Mm^3/year in 1950 to around 2600 Mm^3/year in the following periods, because of upstream diversions by Israel and Syria. Deducting rainfall water directly evaporated from crops and bare soil, renewable blue water shows a similar drop by 50%, with a slump at 671 Mm^3 in 2000 (Fig. 2.5). The CRBW is significantly lower, since uncontrolled and/or brackish flows from the Yarmouk (now controlled by the Wehdah dam) or Israel are discounted. Strikingly, withdrawals (gross diversions of surface water plus abstracted groundwater minus interbasin transfers) now amount to 660 Mm^3/year, or 107% of CRBW, because of groundwater overdraft and multiple diversions (return flows from wadi irrigation or from Amman are reused downstream). Annual withdrawals have continuously and dramatically increased in the last 50 years, from 101 Mm^3 in 1950 (20% of the CRBW) to 316 Mm^3 in 1975 (58% of the CRBW), and 660 Mm^3 in 2000. In 2000, only 130 Mm^3/year of controllable blue water made it to the Dead Sea (Courcier *et al.*, 2005). Figure 2.5 also shows the evolution of the intended beneficial depletion (irrigation and M&I), which almost equated to CRBW in 2000. Overdraft of aquifers now reaches 32 Mm^3/year (Courcier *et al.*, 2005). Figure 2.6 shows the terms of water balances.

This water accounting pools together four different kinds of water sources – groundwater, surface water (controlled by dams), stream water (uncontrolled flows that are diverted) and efficient rainfall (used by irrigated and rainfed crops) – in a single category: water use (or withdrawals). These four categories of water sources are, however, not equivalent because the degree of control managers/users have over them varies highly (in decreasing order in the above list) (Molle, 2003). It is therefore instructive to disaggregate water use into these four categories and to plot these fractions against time. By so doing, and including projections for 2025,[7] we obtain a view of both their relative importance and time dynamics: Figure 2.7 first shows that (effective) rainfall on rainfed crops constitutes the major category of beneficial water, even in such arid conditions. It is also striking that groundwater abstraction in the LJRB now appears as a source of greater magnitude than (controlled) gross diversions of surface water (275 Mm^3/year against 120 Mm^3/year in 2000), although this will be reversed when the Red–Dead project is in operation (see later). Surface water follows the construction of the dams, while stream water includes side-wadis and Yarmouk diversions: stream water increases with the construction of the KAC (supplied by water diverted from the Yarmouk) but decreases as dam construction shifts water from the stream water category to the surface water category.

Sectoral water use

Sectoral water use has changed widely over the last 50 years (together with the projection for 2025). While total agricultural withdrawals have levelled off since the mid-1970s, M&I withdrawals reached 31% of total withdrawals in 2000 (M&I depletion amounts to 10% of total withdrawals) and are expected to hit 52%

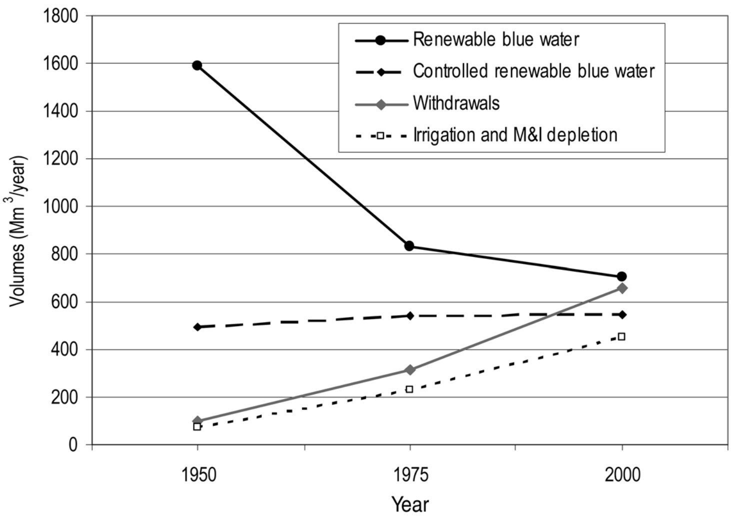

Fig. 2.5. Evolution of net inflow and available water in the Jordanian part of the LJRB.(M&I = municipal and industrial.)

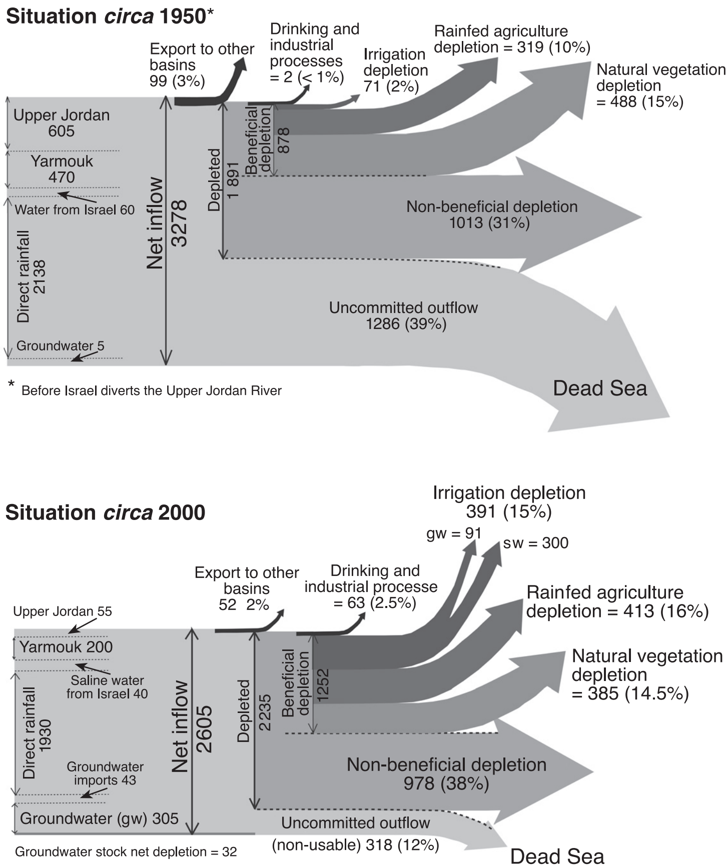

Fig. 2.6. Finger diagrams of water balances in the Lower Jordan River basin in Jordan in 1950 and 2000.

in 2025 (Courcier *et al.*, 2005). This evolution will reproduce that observed in Israel, where agricultural water use remains, by and large, stable, but increasingly relies on treated wastewater, while M&I uses benefit from increases in supply and eventually supersede agriculture. The share of groundwater in M&I is dominant but this situation will also be inverted with the supply of the Red–Dead project.

Water options and the distribution of benefits and costs

Faced with conditions of water scarcity, societies have three broad types of options at their disposal (Molle, 2003). First, they may increase the amount of water that is controllable for human use; this is the conventional supply augmentation option. Second, they may try to conserve water, either by reducing demand or by serving more users with the same amount of water abstracted. Third, they may keep the current level of withdrawals but reallocate water among uses and users. These three options, water resources development, conservation and allocation, can be resorted to at different scales, typically those of country (national policies), basin or local levels. When considering nested scales it becomes clear that these categories are not ‘waterproof’ (for example, mobilizing water locally by, say, small dams may be seen as reallocation at the basin level) and that the three options are resorted to concomitantly.

Which of the three options is selected depends on the respective costs and benefits

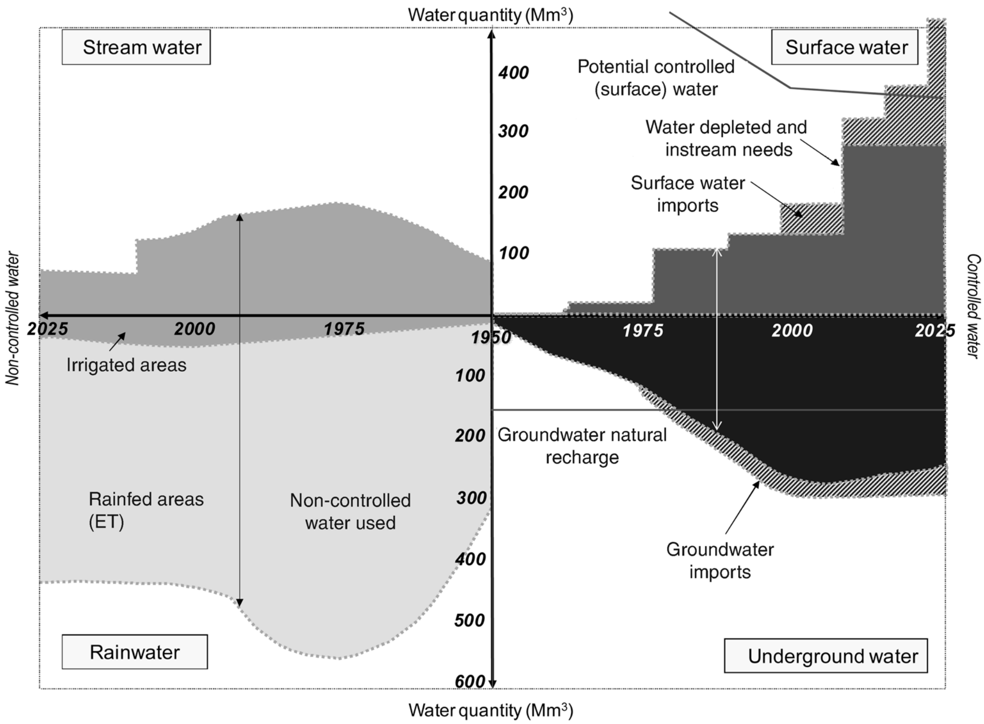

Fig. 2.7. Water withdrawal trends in the Lower Jordan River basin in Jordan from 1950 to 2025 according to four water 'categories'.

attached to these options and on the social distribution of these costs and benefits among concerned parties (politicians, private companies, marginal groups, irrigators, cities, development banks, etc.) (see Molle *et al.*, 2007 and Chapter 1, this volume). Costs are not only financial but also political, environmental, or expressed in terms of risk, health impact and benefits foregone. Likewise, benefits are not only monetary but often political, or expressed in terms of amenity and prestige, for example. It is the relationship between the distribution of decision-making power and the potential social distribution of the costs/benefits attached to each option that largely determines which actions are taken. This section examines the main options offered to the Jordanian society through this lens.

Supply augmentation

Most water sources have now been tapped and the costs of mobilizing additional water resources are ever increasing. These costs, which have until now been supported by the government and international aid (expensive dams, long-distance transfers, elevation costs, desalination, etc.; see GTZ, 1998; Nachbaur, 2004), may have to be increasingly borne by the population in the next decades.

The last reservoirs, which are likely to be built on side-wadis, are generally far from consumption centres, smaller and expensive. One of these, located on the wadi Mujib, which flows directly to the Dead Sea, has recently added a capacity of 35 Mm^3/year. The last main reservoir to have been built (after being delayed for several decades) was the Wehdah (unity) dam on the Yarmouk. It has a storage capacity of 110 Mm^3, for an annual inflow of 85 Mm^3/year (THKJ, 2004).[8] The consequence is a nearly complete disappearance of the lower Jordan River flow as well as that of lateral flows (Mujib dam) reaching the Dead Sea. The resources made available will be diverted mostly to cities.

In the situation of extreme scarcity characteristic of the country, large transfers have long been envisaged (transfer of fresh water from Lebanon, Iraq, Syria and even Turkey; transfer of sea water from the Mediterranean Sea to the Dead Sea (GTZ, 1998)); but these transfers have never been implemented because of the regional political instability and their very high costs in terms of investment and O&M. A large transfer from the fossil aquifer of Disi, located about 325 km south of Amman, has now been funded (at a purported cost of US$990 million), and finally entrusted to a Turkish company. The project is to provide 100 Mm^3/year, extracted by 65 wells at a depth of 500 m. According to the Water Minister, Raed Abu Soud, 'The capital [Amman] will get water from the aquifer for the coming 100 years' (Terra Daily, 2008b), while experts speak of 50 years (Terra Daily, 2008a). Uncertainty about the yield of the aquifer is paralleled by doubt about the fate of the existing irrigation based on the same aquifer (which consumes 80 Mm^3/year), as experts explain that the two uses are incompatible (IRIN, 2007). The issue is considered as 'sensitive' because 'there are tens of farms owned by former high-ranking officials with thousands of employees, the majority of them expatriates' and the government is still 'considering revoking licences for many farms in the area' (IRIN, 2007).

The Disi project is dwarfed by a US$5 billion plan to transfer seawater from the Red Sea to the Dead Sea over a distance of 180 km. A large transfer (1500 Mm^3/year in total) is planned in order to supply the main cities of Jordan, Palestine and Israel, but a first phase of 800–1000 Mm^3/year should bring to the Dead Sea a volume close to that historically contributed by the Jordan River. Seawater would be desalinated on the shores of the Dead Sea using the electricity generated by the natural difference in altitude (400 m) (Harza, 1998). The project has been alternately justified as the mother of all solutions, a means to restore the Dead Sea and its value to the three main monotheist religions, a means to counter environmental degradation and salvage the tourism industry, a solution to urban water shortages, and a way of fostering regional collaboration and contributing to the peace process in the region (the project is also known as the 'peace conduit'). The World Bank and several country donors are supporting a feasibility study of this multi-billion dollar project, launched in December 2006. This project bears all the characteristics of mega-projects: a relatively secretive planning and design, and an array of justifications that borrow from discourses on state building, national security and peace building, and is likely to face massive cost overruns (Flyvbjerg *et al.*, 2003). Other local desalination projects of smaller scale are also being planned or implemented.

Another supply augmentation option is to reclaim wastewater to make it reusable in agriculture. It is forecast that, from 2025, Amman will produce 100 Mm^3 of wastewater each year. We have seen earlier that more TWW would be sent to the Jordan valley and that this raises a host of economic, cultural and health-related issues.

Last, a marginal increase in freshwater supply might come from the implementation of the 1994 Peace Treaty between Jordan and Israel: Israel is bound by the treaty to desalinate the 20 Mm^3 of saline water it now dumps each year into the Jordan valley, below Lake Tiberius, and will transfer half of this volume to Jordan.

Conservation

Water crises serve to increase scrutiny of the 'losses' occurring in man-made conveyance and distribution networks. Urban supply networks, notably those of Amman, have been targeted by several recent projects. Unaccounted-for water, which includes losses by leakage (and non-payment), was around 50% and is supposed to have been reduced to around 30% in Amman, after network rehabilitation and better management. A new US$250 million plan to rehabilitate old water networks is also underway (Terra Daily, 2008b). Additional measures have included public campaigns to raise awareness and encourage rationing in times of drought, and relative increases in prices. Recent announcements (April 2008) of further hikes have, however, caused havoc, showing the social sensitivity of price increases in a context of rising commodity prices.

Agriculture is also often designated as a wasteful user, and alleged low efficiencies of irrigation networks have also been targeted. In the highlands, as mentioned earlier, the various policies implemented have had limited impact, and improving irrigation technology, at best, reduces return flows to the aquifer (and therefore creates no net savings) or, at worst, leads farmers to capitalize on lower per hectare water requirements to expand cultivation (since land is not a constraint), thus increasing total water depletion and worsening the status of the aquifer. Raising prices to disqualify low-value olive trees will only lead to wells being sold to farmers engaged in a capital-intensive agriculture that is associated with higher depletion rates. Consequently, the only way to effectively curb abstraction is to buy wells back from farmers, and offer compensation for discontinuing licences, a measure considered positively by many farmers in the Amman–Zarqa basin (Chebaane *et al.*, 2004). Reaching a sustainable level of groundwater exploitation would require discontinuing all agricultural groundwater abstractions. It seems unlikely, however, that from a role of producer–exporter of fresh products Jordan will become a net importer of these products. Moreover, as seen earlier, policies to reduce irrigated agriculture in the highlands are likely to face fierce opposition and to be delayed and only partially implemented, if at all.

The scope for conservation in the valley is somewhat larger, although equally limited. Part of the inefficiency comes from dysfunctional distribution at the level of the collective pump stations, and pilot projects have shown that redefinition of water turns could improve reliability, while other efforts have been devoted to building up water user associations (GTZ, 2001, 2002; Van Aken, 2004; MREA and JVA, 2006; San Filippo, 2006). Quotas for vegetables are already so low that it is hard to imagine any substantial gains in efficiency; some improvements can still be achieved in citrus and banana plantations, which enjoy larger quotas, and retrofitting of on-farm distribution networks has been found to be profitable because of the improved application of water and resulting gains in yield and quality of products. All these gains, however, are achieved with a full consumption of quotas. Decreasing demand through a hike in prices is not feasible: with two-thirds of O&M costs recovered in the valley it is hard to imagine price increases much beyond the O&M level, at which elasticity of demand is negligible. Here too, as shown by the rationing implemented in the past decade, effective cuts in water diversions were obtained by reducing quotas, not by price incentives (Molle *et al.*, 2008).

(Re)allocation

Reallocation is the most delicate option and arguably the most politically stressful. Irrigated agriculture consumes two-thirds of the national water resources (THKJ, 2004) and competes with domestic and industrial uses, which have been officially declared a priority (THKJ, MWI, 1997). The competition with agriculture in the highlands is indirect, because water from most distant wells can hardly be transferred to cities, and in the long term, because the actual overdraft of the aquifers decreases the resources potentially available for future urban use, as well as their quality, and implies that more costly alternative resources will have to be tapped.

Water has been, and will be, reallocated out of agriculture in the valley, although the impact has been smoothed by the supply of TWW. An important aspect of this sectoral competition is the growing vulnerability of agriculture to climatic vagaries. As the overall residual water user, agriculture in the valley bears the brunt of the variability in supply (see Chapter 1). Compensation measures for fallowing land or in case of reduced supply (as in 2001) need to be considered in order to avoid financial and livelihood breakdowns. As seen earlier, further reallocation can be effected through reduction of quotas. In 2004, however, in contradiction to its policy to reduce demand, the JVA legalized citrus orchards planted illegally between 1991 and 2001, granting them the higher citrus allocation instead of the vegetable quota they received earlier. This illustrates the political clout of the Ghzawi tribe, well established in the northern part of the valley, and the way tribal solidarity and national policies may overlap or conflict with each other.[9]

Reallocation of water among farmers in the Jordan valley can be envisioned if, following the completion of the Wehdah dam, annual quotas can replace the actual monthly quotas;

the possibility of trading water would then enhance both irrigation and economic efficiency, but this would require a quite elaborate system of monitoring and computing of individual water diversions, with effective valley-wide mechanisms to move allocations from one user to another. Fine tuning of irrigation supply would do away with overirrigation in (the rare) times of excess supply but would substantially reduce leaching of salt. There are serious reservations and worries about whether this might also have an impact on soil salinization (McCornick *et al.*, 2001).

Reallocation from low-value to high-value agriculture can also be obtained by incentives to farmers to either change their cropping patterns or lease/sell their farms to entrepreneurs. Higher water prices, or removal of tariff barriers, would, for example, decrease the profitability of marginal, subsidized and/or thirsty crops, including 'luxurious' olive trees in the highlands, and citrus or banana in the Jordan valley.[10] Two types of farmers are concerned, with two corresponding obstacles to policy implementation. Some of these crops are grown by (sometimes wealthy) absentee owners who are interested in prestige or leisure and not in agricultural returns, and who are therefore insensitive to price incentives. In addition, as mentioned earlier, these landowners are linked to influential tribes or to political elites and are likely to oppose such policies. A second group is composed of vulnerable farmers with little capital, labour or willingness to face the risk of intensifying their practices. High-value, profitable crops are already an option for them and there are good reasons/constraints why they have not opted for them earlier. Positive incentives that reduce capital and risk constraints, offering subsidies for improving irrigation technology, attractive cropping alternatives, and exit options with compensation should be implemented if prices are to be raised (Venot *et al.*, 2007).

A political ecology of responses to water scarcity

While all these options are on hand and have been floated for a number of years, most have not been implemented or have met with limited success. The overall decision-making process is highly political and is based on a constant reassessment of the costs and benefits incurred by the different categories of actors and by the environment, in both the short and the long term. Financial and economic costs that form the heart of conventional cost–benefit analyses only capture part of the story. Political arbitration remains central to decision making.

This is not the place to make a detailed analysis of Jordanian society, but a few groups have already appeared in the preceding discussions: the royal entourage, the different Bedouin tribes, Bedouin and Palestinian entrepreneurs in the valley and the highlands, impoverished farmers, urban-based landowners, migrant labourers, the aid industry and national/transnational expert systems. These categories are interlinked by relationships of economic power, patronage and social stratification. The constant confrontations of interests, ideologies and power at the interface of these groups define which actions are taken or not. Complexity is added by the fact that these confrontations are not restricted to water decisions, but include other hot issues (land, economic liberalization, shrinkage of the state sector, agreement with WTO, the Palestinian question, etc.), which signal the embeddedness of water policy within the wider political arena.

Table 2.1 illustrates how the different options reviewed earlier translate into specific costs and benefits to particular actors.[11] Supply augmentation options tend to be the favoured solution of most quarters. They are attractive to development banks, politicians (works are visible political landmarks), water bureaucracies (professional legitimacy and sustained budgets) and the private sector (business opportunities) (Molle, 2008). Because they are capital intensive they also frequently open the way to corruption and private benefits. Costs tend to be shifted to weak or silent constituencies (typically the environment and the next generations) and shifted to the country as a whole (public investments), although the involvement of private investments means that consumers will share an unknown part of the burden. Treated wastewater is a compensation to farmers deprived of fresh water in the valley but entails hidden costs in terms of health hazards for producers and consumers.

Table 2.1. Water sector reforms and interventions in Jordan: a multi-actor perspective on the distribution of costs and benefits.

Costs (black) / Benefits (grey)

	Distribution of costs and benefits									
	International community	Society as a whole	Politicians	Private sector	Farmers and workers	Entrepreneurs/ high-ranking officials	Urban consumers	Environment	Next generations	Tourism industry
Supply augmentation										
Wehda dam on the Yarmouk; smaller dams on side-wadis	Cost, Benefit	Cost, Benefit	Benefit	Benefit			Benefit	Cost		Cost
Import from Disi aquifer	Cost, Benefit	Cost, Benefit	Cost, Benefit	Benefit		Cost	Cost, Benefit	Cost	Cost	
Red–Dead project	Cost, Benefit	Cost, Benefit	Benefit	Benefit			Cost, Benefit	Benefit		Benefit
Desalination plants	Cost, Benefit	Cost, Benefit	Benefit	Benefit			Cost, Benefit	Cost		
Treated wastewater (TWW)	Cost, Benefit	Cost			Cost			Cost		
Peace treaty	Benefit	Benefit	Cost, Benefit							
Farm ponds (farmers in the valley)					Cost, Benefit					Cost
Conservation/reduction										
Reduce leakage in Amman and other cities	Cost	Cost					Cost, Benefit	Cost, Benefit	Benefit	
Improve management collective networks in the Jordan valley	Cost	Cost			Benefit			Cost		
Awareness-raising campaigns	Cost	Cost, Benefit								
Buy out wells		Cost			Benefit			Benefit	Benefit	
Reduce quotas			Cost		Cost	Cost		Cost	Benefit	
Pricing policies			Cost		Cost		Cost			
Improve on-farm irrigation (valley and highlands)					Cost, Benefit	Benefit		Cost		
(Re)allocation										
Reallocate water from the valley to highlands' cities			Cost, Benefit	Benefit	Cost		Cost, Benefit			Cost
Define yearly quotas in the valley										Cost
Pricing policies (reallocate irrigation water or farms to entrepreneurs)		Benefit	Cost		Cost			Cost		
Reduce quotas of citrus and bananas in the valley			Cost			Cost		Cost	Benefit	

The cost of conservation through technological improvement (in Amman's networks, collective or on-farm irrigation) largely depends on who shoulders the capital costs. For high-value crops, entrepreneurs pay for technology because its effect on produce quality, yield and labour makes it profitable. For less risky and capital-intensive crops, adoption of technology is not attractive and depends on government financial support and promotion by extension services. Negative incentives alone, through price increases or reduced quotas, are likely to spark opposition or social unrest and to give way to negotiations and weakening of the measures (as for the by-law on groundwater use).

In order to understand the contemporary political framework in relation to water it is useful to be reminded here of some events. In 1988, King Hussein declared Jordanian disengagement from the West Bank, an important political act towards the Jordanian population of Palestinian origin. In April 1989, riots exploded in the town of Ma'an, in southern Jordan, when subsidy reductions on certain basic items were announced in accordance with a debt-rescheduling agreement with the IMF. Riots and opposition also shook southern Jordan in the 1996 'bread riots', and later in 2003. It is feared that recent increases in the price of commodities will lead to further demonstrations (Al-Jazeera, 2008; LA Times, 2008). It is important to note that these demonstrations developed in areas dominated by tribes once highly loyal to the Hashemite regime but who felt marginalized in the redistribution of resources.

As Richards (1993) put it:

> In Jordan, all government decisions must be viewed through the lens of His Majesty, who must balance contentious internal and external forces. It is the calculus of the 'balancing act', not economic logic that determines all economic (and other) policies. The costs of offending important political actors, whether domestic or foreign, must be offset by tangible benefits.

Agriculture is viewed mainly as a source of patronage for key constituencies, whose support is essential to achieve domestic stability/foreign policy goals. Some landowners in the highlands and many farmers in the valley belong to influential Bedouin tribes that provide important support for the King, such as the Adwani tribe in the valley, whose members are well represented in the army and government bureaucracy. Maintaining their support, in particular against young urban Islamist radicals, is very important for the King, and sectoral or economic policies must therefore offer 'packages' in which compensations are extended to adversely affected constituencies (Richards, 1993). This provides hints on why many agricultural or pricing policies are watered down, circumvented or delayed. Relationships between the King and Palestinians are also important 'given the Palestinian private sector/ Transjordanian public sector divide, and given the fact that economic liberalization targets a shrinkage in the state sector and an encouragement in the private sector, it is not surprising that Transjordanians felt threatened by the economic restructuring' (Brand, 1995). Past conflicts with Palestine – and the lack of a solution to the problem of refugees – still loom large.

Regional politics (not addressed in this chapter) also appear in several issues: the peace agreement between Israel and Jordan and the transfers of water attached to it, and also the lurking competition with Israel on whether the Red–Dead project will prevail, as opposed to alternatives to transfer water from the Mediterranean Sea, over which Israel would have full control. Because of the regional political situation and financial needs, the Red–Dead project will have to be facilitated by international aid or funding agencies, and bringing up environmental (save the Dead Sea), religious (the cradle of three religions) or political (the peace conduit) arguments may allow Jordan and Israel to shift parts of the costs to the 'international community.

Conclusion

This chapter illustrates the gradual anthropogenization and complexification of the lower Jordan River basin over a time-span of 60 years. It describes a striking transformation from the situation around 1950, when only 10,000 ha were irrigated, groundwater was untapped and abundant water flowed to the Dead Sea, to the current situation, when nearly all surface resources are diverted and committed and groundwater is being severely overexploited. This trajectory has revealed a drastic concomitant change of societies and waterscapes in an arid region subject to dramatic political tensions and socio-technical change.

Mobility of social groups has had, and continues to have, a major impact in framing the trajectory of the basin: the tradition of transhumance and nomadism of tribal pastoral groups, interconnected with agricultural settlements and fluxes of rural labour, the past slave trade, the two main shocks due to the forced migration of Palestinian refugees, the migration of workers from Pakistan and Egypt and the hundreds of thousands of Iraqis who recently found shelter in Jordan have been major drivers of the changes of the waterscape of the LJRB. In addition to migrations and displacement, mobility also refers to contacts with the 'outside', including fluxes of exogenous ideologies and institutional actors in the management of resources and flux of capital to a rentier economy (from remittances and the aid industry and also, more recently, from economies at war and from Gulf countries).

Water projects have constituted a main tool in the search for stability, both with regard to regional competition for this scarce resource and in terms of internal stability: an instrument to settle and 'root' nomadic populations and to depoliticize a tense context; a vehicle for building up bureaucracies, which would be pivotal in the distribution of resources and the development of patronage; a form of consensus building and modernization of the nation; a way to 'solidify' the border in a disputed frontier area; and a means to cement regional peace and obviate wars. All these have been determining elements in shaping patterns of water resources development and management and in defining new relationships between the state and citizens, between tribes and the state, and between farmers and engineers.

The waterscape of the LJRB, first occupied by Bedouins and small rural settlements, witnessed the emergence, or the occasional presence, of actors as diverse as Palestinian or Iraqi refugees, Pakistani or Egyptian workers, sheikhs from the Gulf region, peace negotiators, greenhouse entrepreneurs, irrigation bureaucrats, foreign development experts, researchers, international bankers, tourists, Islamic fundamentalists, urban absentee owners with swimming pools in their orchards, Bedouin farmers using desalination plants, and prestige olive-tree gardens watered in the middle of the desert. These actors have contributed to the peculiar trajectory of the LJRB.

Bedouin tribes who controlled natural resources, interlinked with peasant settlements, were the first to be targeted by irrigated settlement schemes (in both the highlands and the Jordan valley), construed as a basis for nation building: their incorporation into the state apparatus has been the counterbalance to the disruption of their pastoral economy and also the basis of the adaptation of tribal solidarity within the new political system.

Rural livelihoods have shifted from livestock, rainfed cereals and olive trees, with spots of seasonal irrigated farming, to an artificial, 'plastic' and intensified agriculture, partly linked to export markets and also to rentier strategies (irrigated olive trees in the highlands and some citrus orchards in the valley). Palestinian technical knowledge, foreign aid and immigration of foreign labourers (the often 'invisible' water users in agriculture, under the dependence of their patrons and managers) have been pivotal in agricultural development. Technological change, in particular micro-irrigation and pressurized networks, has made water users interdependent in a social context characterized by social/ethnic heterogeneity and by the fragmentation of previous social networks and forms of cooperation. Waterscapes have been reshaped from small springs and streams diverted to family gardens and communal patterns of distribution of land and water in the integrated agro-pastoral management to a centralized bureaucratic system with water pumps and pipes lifting water 1000 m up from the valley bottom and from distant aquifers to cities. Water is thus largely de-territorialized, since it has lost its ancient linkages with land and local communities. Both the valley and the highlands, on the one hand, and agricultural areas and cities, on the other, are thus interconnected and interdependent. This interdependence manifests itself in terms of competition (water quantity) and also more and more in terms of water quality.

Around 2000, 64% of surface runoff and groundwater annual recharge was depleted through irrigation and M&I depletion, and this percentage springs up to 83% if we disregard the uncontrolled flow of the Yarmouk to the Jordan valley. At present, the basin is closed, as most of the water is mobilized and depleted. Because of the reuse of water and of current groundwater overdraft, withdrawals amount to 107% of controllable blue water. Resulting environmental change has included depletion of aquifer systems, springs drying up in oases and salinization of groundwater, as well as the lowering of the level of Dead Sea by over 20 m. It is also important to note that the high percentages of controlled and depleted volumes are obtained even though we have considered the Dead Sea as a sink with no 'needs'. Environmental considerations have de facto been written off as a result of the diversion of the upper Jordan by Israel but are back on the agenda, as illustrated by the debate around the Red–Dead project.

A new cycle of pressure over water resources, continued concentration of power and water use in urban centres, and capital investments is being triggered by the recent inflow of Iraqi refugees. Among competing solutions, conservation offers a limited prospect: the Wehdah dam has brought controlled blue water resources to the level of 93% of the total renewable blue water, irrigation efficiency has been drastically improved through micro-irrigation, and percolation losses in highland agriculture largely return to the aquifer. Consequently, the scope for water savings at the local and basin levels is much reduced. Control of leakage in Amman and further efficiency gains in the valley are desirable, but they will not radically alter the facts that a ceiling has been reached and that demand-management options may only alleviate the actual situation without providing long-term solutions. Typical capital- and technology-intensive supply augmentation projects, namely large-scale interbasin transfers (Disi, Red–Dead) and desalination, may therefore be the sign not only of a lasting dominance of the engineering approach but also of the exhaustion of resources in the face of a new boom in population.

Yet the permanence of the use of scarce resources in low-value agriculture (olive trees and citrus), in subsidized thirsty crops (bananas) or by rich private entrepreneurs (Disi's fossil water) constitutes an economic 'anomaly' that makes water import or desalination projects look suspicious, since the cost of water will be much higher than its opportunity cost in these agricultural activities. Political objectives and constraints, as is often the case, override economic considerations, and agriculture keeps a role in buying loyalty from some Bedouin tribes and rewarding high-level officials. Threats to vested interests inherent in demand-management measures raise the political costs of these policy options. The gradual intensification of agriculture towards a capital- and knowledge-intensive activity also has implications for weaker segments of the population in terms of social stratification, access to land and distribution of benefits, and stresses the importance of compensations and of the availability of alternative activities for those who are pushed to give up agriculture.

As a closing basin, the LJRB is characterized by an increasing interconnectedness of uses and users through a hydrological cycle reshaped by human technology. But technology allows a reversal of gravity and water to be pumped from the valley to the highlands, in a manifestation of the sectoral competition over water, and of the economic and political power of urban users. In agriculture, entrepreneurs, family farms and rentiers also compete for water, in both the valley and the highlands, with their respective strategies and assets – financial, political or otherwise. The weaker and the most downstream 'user', the Dead Sea, is the ultimate loser. These intricate influences of social, economic and political factors in the shaping of the LJRB's future trajectory illustrate the inherent and strong coupling of the evolution of both societies and waterscapes.

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Notes

1 The water-accounting exercise presented here draws on the categories of water balance proposed by Molden (1997). For more details on data sources refer to Courcier *et al*., 2005 and Van Aken *et al*., 2007.

2 Average rainfall distribution is adapted from EXACT (1998).

3 Recently, the process of privatization has been slowed down. For example, after 2006 a public company (Mihayuna) replaced the private one in charge of the management of Amman's water utilities. At the same time, several projected privatizations have been delayed (notably one concerning the privatization of the Jordan Valley Authority, the public agency in charge of water management in the Jordan valley).

4 The WTO, the Jordan–EU Agreement, the Great Arab Free Trade agreement establishing a free trade area between the Arab states, and several bilateral agreements, notably with the USA and Israel.

5 At the time of our accounting, flash floods included 110 Mm^3 from the Yarmouk River, which could not be stored and flowed to the Dead Sea. Those are now (2008) captured by the recent Wehdah dam, constructed upstream of the intake of the KAC.

6 The CRBW amounted to 493, 543 and 545 Mm^3/year in 1950, 1975 and 2000, respectively. With the completion of the Wehdah dam CRBW is 655 Mm^3/year.

7 These include: the recent Wehdah dam on the Yarmouk River, increasing water imports from outer basins, the construction of several desalination plants, the extension of irrigation (with treated wastewater) in the south of the Jordan valley, the reduction of agricultural groundwater abstraction in the highlands, and the first transfers of desalinated water through the Red Sea–Dead Sea project (100 Mm^3/year; against a provision of 570 Mm^3/year for Jordan at completion of the project (Harza, 1998)).

8 In 2007 and 2008, inflows in the Wehdah dam were, however, much lower than expected (this could be due to increased water use in the upper Yarmouk basin).

9 As illustrated by recurring conflicts between members of the Adwani tribe in the southern Ghor and high-ranking officials of the JVA.

10 Alternatives include different types of vegetables and fruits, such as date palm in the valley, which are low water consuming, relatively salt resistant and highly profitable but are capital and management intensive, risky and require good control of marketing.

11 These categories of actors are, of course, simplifications. In reality none of them is homogeneous but consideration of inner diversity is beyond the scope of this work.

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