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Notes on the old water system and the integrated of Jordan future

Jordan is considered one of the most water-poor countries in the world. Jordan therefore faces water crises. The average of rainfall is very law (Jordan is considered an arid region), and surface water is rare too, 90% of rainfall evaporates. The ground water table is also low because of the artesian wells are being drained for use by the agricultural and industrial sectors (Rjoub 1994: 12-15).

According to the geographical studies the eastern part of Jordan consists of three main sections:

(1) A broad plain rising from the center of the desert, i.e. the east and southeast areas;
(2) A hinter land of mountain ranges, i.e. the western areas;
(3) Steep slopes to the main valleys, i.e. the Jordan rift, and the al-Azraq, Wādī as-Sirḥān Basins and al-Jafr basins (FIG. 1).

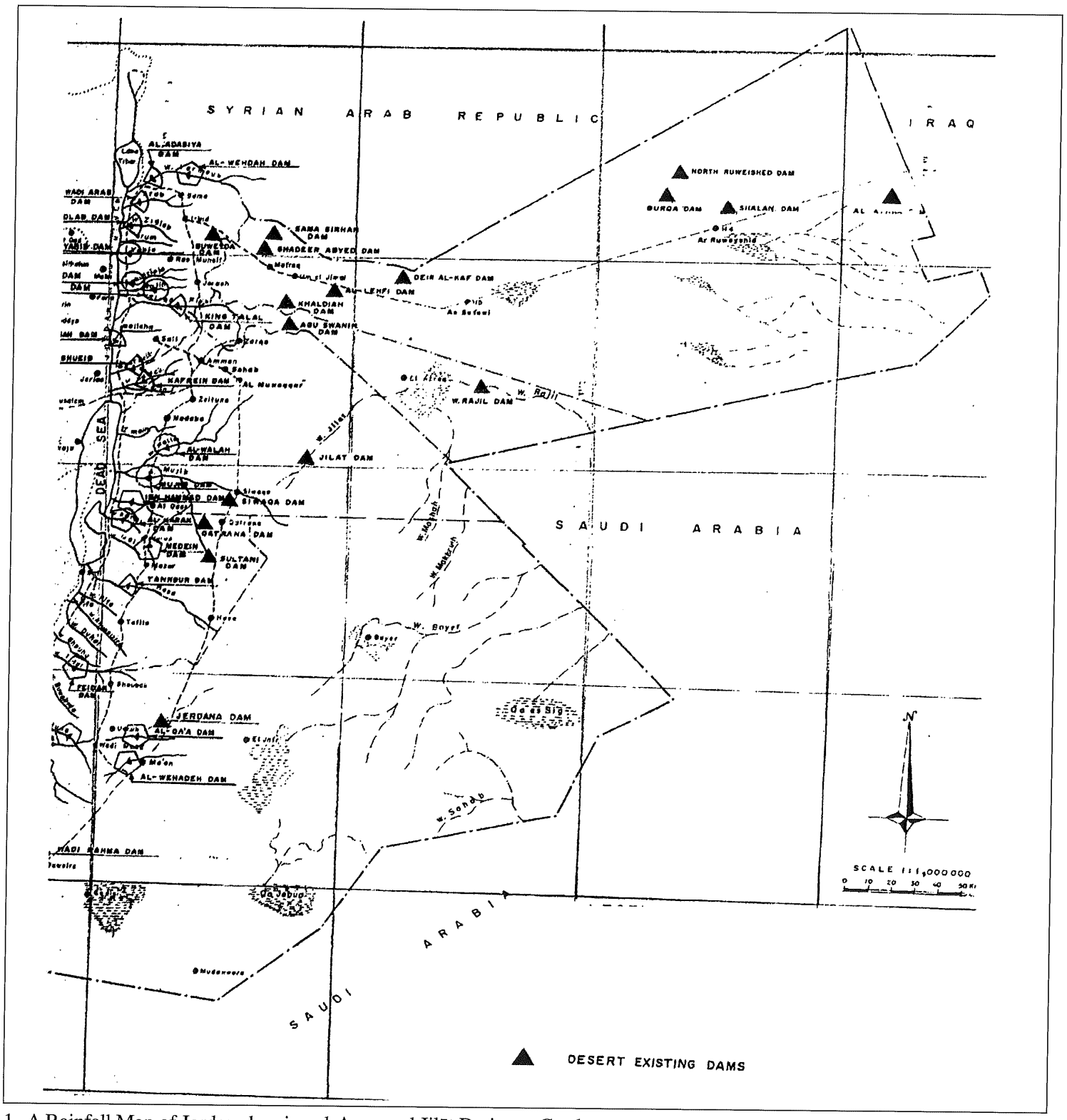
Currently, Jordan has a Mediterranean climate although temperatures in Trans-Jordan are more extreme. Temperatures in winter rarely fall below freezing and most rain falls in the winter months, although actual rainfall varies according to the region:

(a) Annual rainfall in the Mediterranean zone is 200-600mm, temperature 20°C in the north western part of the country, declining to the low levels in the barren eastern and southern areas.
(b) Annual rainfall in the semi arid zone 100-200mm, temperature 30°C.
(c) Annual rainfall in the arid zone is 50-100mm and may be less than that, temperature 37°C. According to the study (Abed 1994: 9-20), 90% percent of Jordan land receives less than 150mm of precipitation per year depending on rainfall statistics.

The number of sunny days approximates 320 during a year so the totally of rainfall (water) evaporates. There is limited evidence for the Paleolithic climate in this region. This region has a few sand dunes stretching along the eastern and southern shores, and the topography of the desert consists also of a series domes in certain sections. These eroded domes form part of the various parallel ancient folds showing dipping chert beds. There are a number of sites which document the developed stages of the lower Paleolithic, e.g. in the mountainous region in al-Azraq basin. The Middle Paleolithic began 80,000-40,000BP. Certain sediments in association with the typical lithic tools indicate a gentle sustained rainfall, which would indicate that the weather may be wetter than today. (Blake 1947: 1-7; MacDonald 1965: 81-82).

During the Holocene Geological age (ca. 20,000-10,000BP), climate was more humidity. There are indications of a small quantity of water, often saline and springs. It appears that more erosion occurred wide caves. This means that climate has some changes through Geological ages. (MacDonald 1988: 26-36). Cenomanian Geological strata have highly developed main springs, water table and wells.

6000 years ago, our ancestors were able to collect water and that made al-Bayḍa a place to live in and witnessed the development of the greatest and one of the oldest civilizations in the East. Those ancestors have, since the Neolithic age, worked hard to build settlements close to a river or a spring bearing in mind their ability to protect and defend this water source, which represents life to them; later on it became like a sanctuary. They repaired any damage or erosion to their settlement resulting from the elements. The relationship between water and life and the system of distributing water among all creatures on the earth has therefore been long recognized. As has the fact that water keeps body and mind healthy by means of scientific, agricul-



1. A Rainfall Map of Jordan showing al-Azaq and Jilāt Drainage Catchments.

tural and economical practices which used trial and practice as a source of knowledge and invention, this is common in any rate of creatures.

70% of Jordan is classed as semi desert (NRA 1977, brochure issued from Natural Resources Authority of Jordan) therefore, the inhabitants of this country, pioneers in settlement, were obliged develop different methods of living such as systems of collecting water, such efforts were accompanied by creating an authority to control these sources and to use them in dry seasons.

The remnants of archaeological sites in Jordan have revealed the existence of unfamiliar water systems

- A water reservoir was discovered inside al-Bayḍa area, in Petra, dating back to the Neolithic period

(Kirkbride 1985). This reservoir has been reused again in the second phase of this period.

- At Jāwā, located on the borders between Jordan and Syria, a comprehensive irrigation system has been discovered, it dates back to the end of the 4th Millennium thousand BC. It is one of the oldest systems, which incorporated natural pools (Helms 1981: 145-187).

Helms shows that rain water was gathered and collected by mathematical and scientific systems depending on natural storages (i.e. the low area to the east of Wādī Rājil was used as a natural water trap), (1983) which resulted in a significant volume of water (see TABLE 1).

- By the end of the second millennium BC a new method to strengthen reservoirs appears this allowed water to be kept for a longer period and involved more elaborate canal systems, irrigation wheels and more widespread use of surface run-of (TABLE 1).
- The Arab Nabataens were distinguished in rain water collection. Their methods included:

a) Digging rock-cut cisterns in rocks because rocks do not absorb water e.g. Umm al-Biyāra (Mother of Cistern), Wādī 'Araba, Wādī ath-Thamad and an-Naqab (Glueck 1965: 315-319) see TABLE 1.

b) Terracing along the banks of valleys so that water could cover a larger areas before it is lost down the valleys (Evenari and Koller 1956; Hammond 1967).

c) Making rectangular and square sealed reservoirs to reduce evaporation in many areas such as Wādī 'Araba (Glueck 1959: 201). Umm al-Jimāl (Mother of camels) and others (Devries 1993) see TABLE 1.

d) Making canals and bridges (aqueducts) to carry water by making use of its pressure. This method was well known in the Hellenistic-Roman period the Eastern Deserts (Bianchi and Faggella 1993; Oleson 1996).

e) Using networks of water and a system of secret or hidden pools e.g. Nabateans (Ball 2000: 46; Watson 2001) see TABLE 1.

Throughout history religious sources and other inscriptions describe water as an essential element of life.

- Water systems were described during the kingdom of Moab ca. 840BC. The King Mesha' Stela note that the king ordered the reconstruction of pools and the reclamation of the high lands for run-of systems for irrigation and erosion prevention.[1]
- In the Ammonite inscription on the Seiran bottle – King Amen-dab (ca. 700BC) ordered the planting of fruit trees and the construction of pools (Thompson 1973).
- A Latin inscription from Mādabā dedicated wholly to Neptune, god of water. (Unpublished inscription; altar erected now in Mādabā museum. The inscription reveal something of the town's culture during the period of the Roman administration).
- In the historical documents of the Byzantine churches (Onomasticon) the importance of water cisterns are mentioned frequently for instance, an inscription noting Christ as the source of life was discovered inside a carved cistern in Madaba (Piccirillo and Donton 1997: 25-26) see TABLE 1.
- In a water cistern at al-Yādūda, (Brochure written by Judith Cochran and Stein LaBianca 1994 'Ancient water management') discovered a relevant saying was written on a stone: "We sent down water from heaven abundantly and lodged it in the earth ....". A verse from the Holy Quran, the Believers 23:18.

We could say that our ancestors have provided us with lots of technical methods for the preservation of water, which form an important part of. Our heritage as they document a large part of the relationship between our ancestors and their living practices. We still have these examples of these in Jordan because they have been preserved despite the weather conditions, their particular situation, development plans, the economic and information systems. Archaeological discoveries show us that in order to achieve an environmental balance water systems of all kinds were critical. We can use this information to inform modern planning:

1- Sustainable development requires a permanent source of water (TABLE 2).

2- Dams and pools, can play an important role if their construction and ability to store water is properly thought out. Jilāt dam was used for irrigation and for drinking. 'Urayniba Dams provided for more than that also Dayr al-Kahf. These examples date back to the early Islamic ages (see TABLE 1).

3- The water canals in Petra have been used to make a pioneer tourism project that exemplifies

[1] A spring or a pool was considered sacred or gracious (Bedal 2001).

TABLE 1. Archaeological remains of ancient rain water collection (including proposed capacity). Including the map of Jordan.

District	Geographical Region	Kinds of water tanks	Capacity by M^3	Periods
Jāwā (FIG. 3)	North east Jordan desert	Dams Natural catchments	70,000	4th Millennium BC.
Ḥisbān	Al-Balqā' area Hinter land	Reservoir rock cut cistern	8500	1st Millennium BC
Umm al-Biyāra	Petra mountains south Jordan	Rock cut cisterns channels	Each one 500	1st millennium BC-750BC
Mukawir al-mashnaqa	Dead sea mountains	Reservoirs aqueduct	Each one 1000	1st century BC
Petra and Wādī 'Araba, Umm al-Jimāl	South and west part of Jordan North part of desert	Reservoirs, cisterns (30) aqueducts, canals dams, natural dams and natural terrace	Average 1000 5000 40,000	1st century BC to 2nd century AD Nabataen and Roman
Mādabā, Zizyā	Central plains of Jordan, beside desert road	Pools, cisterns pools	60,000 80,000 10,000	3rd century AD to 7th century AD Roman/ Byzantine period
Early Islamic archaeological examples				
'Ammān, 'Urayniba (FIG. 5)	Central part of Jordan Central plain of Jordan	Cisterns	15000	The end of 7th century AD until
	Central plain of Jordan	Dams	200,000	10th century AD
Al-Qasṭal (FIG. 7)		Pools	10000	Umayyad-Abbasid
Jilāt Basin (FIG. 4)	Central part of Jordan, deseret	Dams	300,000	7th century AD to 10th century AD
Al-Azraq Basin	Central part of Northern desert	Pool	10,000	7th century AD to 10th century AD
Al-Muwaqqar palace (FIG. 6)	Central part of Jordan, desert	Pool	25,000 5000	7th century AD to 10th century AD
Dayr al-Kahf (FIG.2)	Northern part of Jordan	Dam	200,000	7th century AD

water systems and supports a service to tourism facilities.

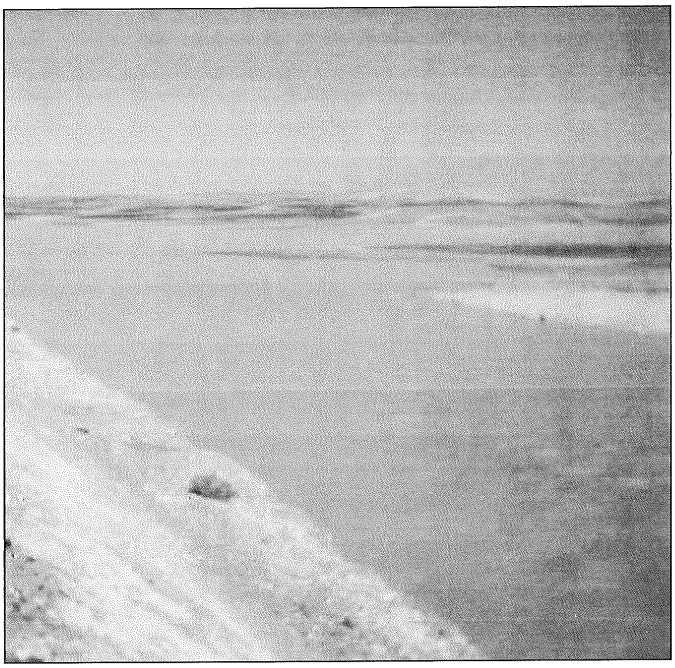
4- Ancient water cisterns existing in villages are often still used again by villagers in 'Ajlūn and Irbid to irrigate olive trees.

5- When preparing any development study, the following sectors have to cooperate: The Natural Resources Authority, the Water Authority, the local universities and the Royal scientific society. They must cooperate in order to choose attractive places with local water source to attract tourists.

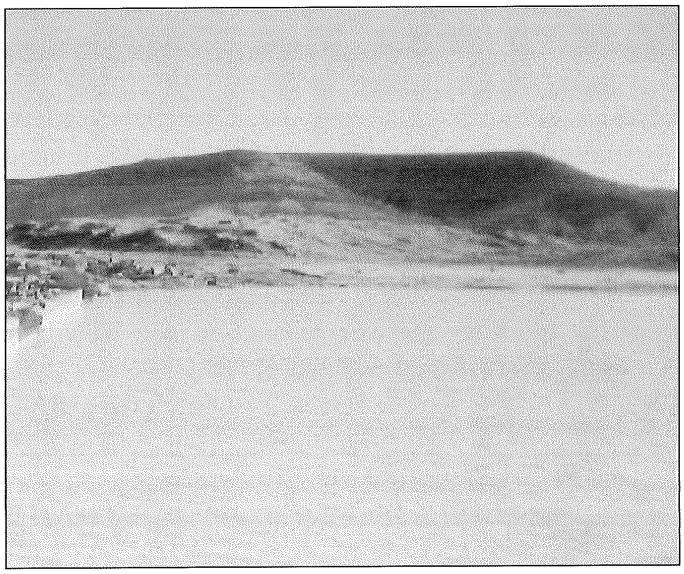
TABLE 2. Water use for Agricultural products area, this is as example if we assume the same range rainfall through ages. Quantities per each 1000m^3 (Taken from: A study of water use of agricultural products. Ministry of Agriculture, Wa'il el-Sharif).

Product	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Wheat	50	90	125	170	175	---	---	---	---	---	---	45	655
Barsim (clover)	---	---	75	70	160	200	215	105	155	154	131	---	1430
Corn	---	---	---	---	---	---	150	95	122	148	120	---	635
Tomato	---	---	---	---	20	70	125	225	270	30	---	---	750
Vegetables	---	---	---	---	---	---	225	140	105	140	135	120	870
Fruits	69	74	95	116	144	160	162	160	135	114	90	70	4310
The total per cubic meter													8650

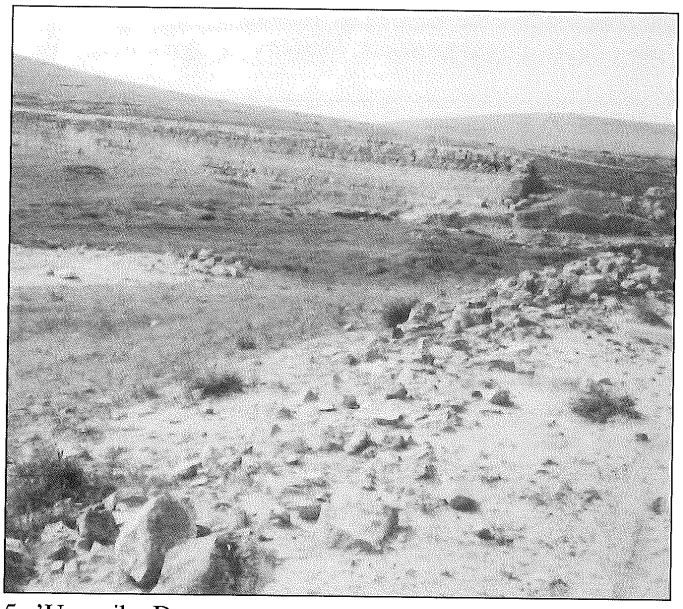
2. Dayr al-Kahf.



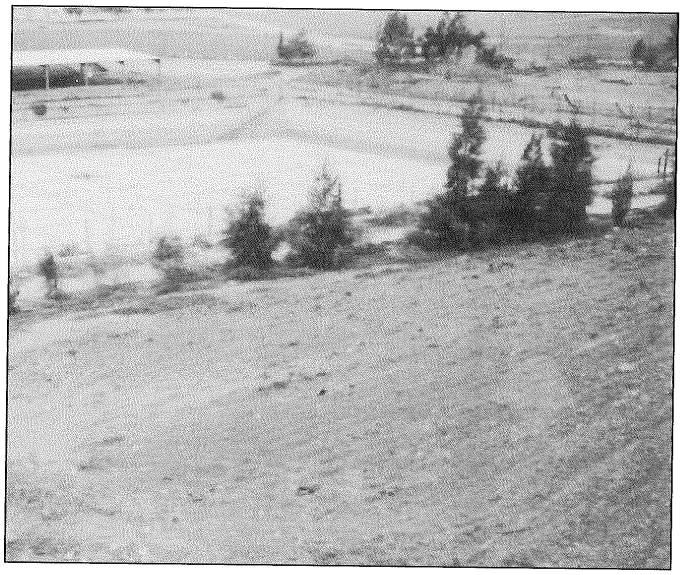
3. Wādī Rājil (Jāwā Water 2003).



4. Jilāt Dam.



5. 'Urayniba Dam.



6. Al-Muwwaqar Pool.

7. Al-Qasṭal Pool.

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