German-Jordanian Programme "Management of Water Resources"

# Farming In The Desert

## Analysis of the agricultural situation in Azraq Basin

2010

giz

Development Cooperation
Hashemite Kingdom of Jordan
Federal Republic of Germany

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

## III – Awareness about water overexploitation: progressive setting of a regulated water management framework

### 3.1. Competition over limited water resource: a threat to the sustainability of Azraq Basin (context and general consequences of overexploitation of water)

The absence of a specific policy that mitigates agricultural expansion and land exploitation has led to a dangerous spread of agricultural investments and a sharp increase in groundwater exploitation over the past three decades. In addition, water was pumped for urban consumption. In 1963 and 1970, small quantities of Azraq's groundwater were pumped to Irbid. In 1980, water used for agriculture was confined only to the springs which flowed naturally near the surface[23]. At that time, the wetland of Azraq oasis was covered with water on a total area 6 km$^2$. In 1981, Amman Water Sewerage Authority (AWSA) began pumping water to Amman at a rate of 1.5 MCM/y. In 1982, AWSA drilled 15 wells in northern parts of the Azraq Oasis in order to meet the domestic water needs of Amman and Zarqa (average well abstraction 17 MCM/y). Today, the total number of agricultural wells is 865, with 481 working artesian wells and a few manual wells[24], mainly in Ratami. Azraq Basin currently provides 25% of Amman's potable water. The total abstraction from the basin almost tripled in 20 years: it increased from 21.6 MCM/y in 1983 to 58.5 MCM/y in 2004. This over-exploitation led to a drop in the water table by 0.3 to 0.8 meter per year, (some wells are reported to have dropped by 20 meters), increasing water quality problems due to dramatic salination of the aquifer or pollution, and to the drying up of the wetlands[25].

Today, the problem of groundwater overdraft remains with over abstraction reaching 215% of the safe limit (definition):

- Safe yield being 24 MCM/y.

- Abstraction reaching 51.16 MCM/y[27] in 2009[26] (27.5 for agriculture, 22.9 for governmental drinking water wells for drinking water and 0.76 for other purposes).

Illegal abstraction from the Azraq basin, which is the abstraction from wells that are registered as "illegal wells", amounts to 13 MCM/y. The situation in North Badia is completely different as 90% of the farms have their wells registered[28].

[23] Wael Sartawi, MoA, 1980.
[24] WAJ Azraq, 2009.
[25] Van Aken, 2007. Historical trajectory of a river Basin in the Middle East – the Lower Jordan River Basin (in Jordan).
[26] Data WAJ 2009.
[27] WAJ Azraq estimations, 2009.
[28] Source: Highlands Farm Survey, 2008, Internal Report, Water Focal Point.

Exploding water abstraction in Azraq area: towards an environmental disaster

Azraq wetland formerly comprised a large area of permanent spring-fed marshes and pools, and a seasonally flooded wetland (Qa'a Azraq), fed by two groups of fresh water springs supplied by the upper of three aquifer systems underlying the Oasis. Extensive shallow wetlands used to host a variety of plant communities and migrating birds. In 1977, Azraq Oasis was included in the Ramsar list of wetlands of international importance.

Before 1970, water usage in Azraq area was confined only to the springs which were flowing naturally. The delicate balanced between water abstraction and preservation of the wetland was already highlighted by Nelson (1973) "The fear is that if too much water is withdrawn the effect on the wetland will be large and irreversible by the time it becomes apparent. Equally important, underground changes due to altered levels might lead to contamination of pure water with brine, thus ruining both the habitat and any practical utilization scheme ". Development of agriculture in Azraq area had already been mentioned, and it was advised not to proceed: "Large-scale irrigation and reclamation of area around Azraq [...] is far from desirable. It would be impossible [...] without creating great pressure on the wetland which would eventually destroy it. The Azraq area is in any case unsuitable for agricultural development by irrigation. Most of the soil is too much salty to make leaching practicable except by using large amounts of water".

But in the early 1970s, 54 private wells were dug for irrigation purposes (abstracting 2 MCM), in spite of the prohibition that was decided in 1971 to stop unlicensed digging. Unlicensed digging continued, the number of wells increased and reached 254 manual wells and 73 artesian wells in 1984 (abstraction amounted to 8 MCM).

The 4 springs progressively stopped feeding the oasis, and in 1992, the entire oasis dried out.

Table 1. Azraq water budget 2009, WAJ.

| Type of Well | Total number of wells | Consumption (MCM) | Non working Wells | Working Wells |
|---|---|---|---|---|
| Legal agricultural well | 304 | 6.3 | 59 | 245 |
| Illegal agriculture well | 561 | 13.2 | 325 | 236 |
| Private governmental well | 13 | 0.7 | 3 | 10 |
| Governmental well for drinking water | 20 | 16.9 | 4 | 16 |
| Wells for herds in remote areas | 11 | ? | 5 | 11 |
| Total | 909 | 37.1 | 391 | 518 |

Table 2. Wells in North Badia (WAJ, 2009): only 51 wells abstract water from Azraq aquifer.

| Type of Well | Total number of wells | Non Working Wells | Working Wells |
|---|---|---|---|
| Legal agricultural well | 345 | 56 | 289 |
| Illegal agriculture well | 6 | 3 | 3 |
| Private governmental well | 11 | - | 11 |
| Private agricultural wells with permits | 5 | - | 5 |
| Governmental well for drinking water | 1 | - | 1 |
| Wells for factories, universities, productive wells | 26 | - | 26 |
| Wells for construction, livestock or for other uses | 13 | - | 13 |
| Total | 407 | 59 | 348 |

## 3.2. Consolidation of Water Management Policies

From 1962 until 1992, licenses were given by the government for drilled wells in Mafraq and Jiza regions. Two thirds of the licenses specified the maximum amount of water for abstraction (allowable abstracted amount); usually 50000 and 70000 $m^3/y$ (and sometimes 100000 $m^3/y$ after 1990). But faced with overall scarcity of water, the drawdown of aquifers and the decline of water quality, several measures were taken by the Government to decrease groundwater abstraction.

In 1992, the drilling of wells was frozen whereby no licenses were given to new wells.

In 1998, the Groundwater Management Policy was promulgated.

In 2002, the Ministry of Water and Irrigation (MWI) of Jordan issued Underground Water Control bylaw No. (85) to control private

agricultural abstraction. This bylaw introduces a system of quotas combined with taxation of any use exceeding the quota. Although this bylaw is very generous in terms of the water quantities and tariff, it is considered the first real attempt to tackle the groundwater situation. Ground water Decree in the year 2002 allows for tariff exemptions (in all areas apart from Azraq) up to 150000 $m^3$/y. In Azraq every individual well has a so-called "specified quantity" that corresponds to approximately 250 $m^3$/du. Special tariffs are applied in Azraq. Illegal wells also have a different tariff and they pay from the first cubic meter.

In 2003, the Regulation No. (76) amended the Groundwater Control Regulation. It created a new category for wells with brackish water: the higher the salinity, the cheaper the water.

In 2004, the first bills corresponding to water consumption were sent to the farmers. No one paid.

In July 2009, WAJ distributed water bills (4.5 Million JD for 2003 - 2010) in the Azraq region but some farmers still refuse to pay their bills.

In February 2010, the Ministry of Interior Affairs gave the order to destroy all illegal farms (farms built on illegally acquired lands) which were younger than 2 years. They make up between 1'000 and 2'000 du. The selection of farms to close down was made by a committee comprised from Badia Police Armed Forces and representatives from the Ministry of Interior Affairs and the Department of Land and Survey.

In March 2010, WAJ redistributed water bills in the Al-Azraq region. Most of these bills were based on estimations (depending on the farm size and the kind of crops planted) because the wells had no meters.

In December 2010, a new Amendment to the Groundwater Control Regulation draft is issued by MWI and awaits approval from the Prime Minister Cabinet. It consisted of increasing water tariffs for drinking and agricultural water. It also included a fixed free quota of 50000 $m^3$ in Azraq.

Evolution of water tariffs for licensed[29] wells:

| Quantity of water pumped | According to 2002 bylaw | According to 2004 amendment | According to 2010 amendment |
|---|---|---|---|
| 0 - 50000 $m^3$ | Free | Free | Free |
| 50000 - 150000 $m^3$ | Free | Free | 0.010 JD/$m^3$ |
| 150000 - 200000 $m^3$ | 0.025 JD/$m^3$ | 0.005 JD/$m^3$ | 0.010 JD/$m^3$ |
| more than 200000 $m^3$ | 0.06 JD/$m^3$ | 0.06 JD/$m^3$ | 0.10 JD/$m^3$ |

[29] With former abstraction licenses

Water prices for wells with abstraction permits:

| Quantity of water pumped | According to 2004 amendment (as licensed wells) | According to 2010 draft Amendment |
|---|---|---|
| 0 - 25000 $m^3$ | Free | Free |
| 25000 - 100000 $m^3$ | Free | 0.010 JD/$m^3$ |
| 100000 - 150000 $m^3$ | Free | 0.100 JD/$m^3$ |
| 150000 - 200000 $m^3$ | 0.005 JD/$m^3$ | 0.100 JD/$m^3$ |
| more than 200000 $m^3$ | 0.060 JD/$m^3$ | 0.100 JD/$m^3$ |

Water prices for wells with no abstraction license or permit:

| Quantity of water pumped | According to 2002 bylaw | According to 2010 draft amendment |
|---|---|---|
| 0 - 100000 $m^3$ | 0.025 JD/$m^3$ | 0.050 JD/$m^3$ |
| 100000 - 150000 $m^3$ | 0.030 JD/$m^3$ | 0.070 JD/$m^3$ |
| 150000 - 200000 $m^3$ | 0.035 JD/$m^3$ | 0.100 JD/$m^3$ |
| more than 200000 $m^3$ | 0.070 JD/$m^3$ | 0.100 JD/$m^3$ |

Water prices for brackish water wells:

| Quantity of water pumped | Salinity according to 2002 bylaw | According to 2004 amendment | According to 2010 amendment |
|---|---|---|---|
| 0 - 50000 $m^3$ | | free | free (1500 - 2000 ppm) |
| more than 50000 $m^3$ | more than 1500 - 2000 ppm | - | 0.015 JD/$m^3$ |
| 50000 - 150000 $m^3$ | 1500 - 2000 ppm | free | 0.020 JD/$m^3$ |
| | more than 2000 ppm | free | 0.010 JD/$m^3$ |
| more than 150000 $m^3$ | 1350- 1500ppm | 0.015 JD/$m^3$ | - |
| | 1500 - 2000 ppm | 0.010 JD/$m^3$ | - |
| | more than 2000 ppm | 0.005 JD/$m^3$ | 0.015 JD/$m^3$ |

Special case in Azraq: water prices for wells with abstraction permits:

| Quantity of water pumped | 2004 amendment | 2010 draft amendment |
|---|---|---|
| 0 - permitted quantity | Free | |
| 0 - 50000 $m^3$ | | Free |
| permitted quantity-100000 $m^3$ | 0.020 JD/$m^3$ | |
| 50000 - 100000 $m^3$ | | 0.020 JD/$m^3$ |
| more than 100000 $m^3$ | 0.060 JD/$m^3$ | 0.100 JD/$m^3$ |

## 3.3. Limited awareness about water shortage within farmers and resistance of the water bylaw

Based on the interviews with farmers, it can be said that most farmers are not aware of groundwater depletion, or at least not relating the problems they are facing to the excessive use of water in agriculture. 35% of farmers consider there is absolutely no problem. Despite the Groundwater Control Bylaw No. 85 (2002) and its amendments about taxation of water used for agriculture, the legal instrument seems to be ineffective. Indeed, as long as no clearly defined procedures and means are deployed on the field to enforce the rules, the law does not offer sufficient control over water abstraction. Water fees seem to play no role in the cost calculations of the farmers. These fees are far below the other farm costs, especially energy and other inputs[30] (fertilisers, pesticides, etc.). This appeared clearly during our survey on the whole Azraq basin, as farmers, when asked about their water bill, they answered with the cost of their electricity bill, suggesting that water is not considered in costs calculations of the farm.

### 3.3.1. The challenging behavioural change in Azraq

In Azraq, 40% of farmers noticed a drop down of the water level of at least 1 to 3 m (the current average is -1 m/y); even some long time settled farmers could testify to a drop in the water level of around 20 meters (5 farms out of the 36 visited).

Salinity of abstracted water is rarely mentioned as a problem by farmers, even if analysis from WAJ in 2002 showed that most wells had saline water. 26 out of 36 wells have a salinity more than 1000 ppm, reaching up to 2150 ppm! Some of the farmers admit to water salinity in order to be able to distinguish their well as a brackish well used for agriculture, to which the lower tariffs being applied (according to Regulation No. 76 (2003)). Most wells in Azraq region could be included in the category of brackish water wells. Soil salination is much more often mentioned. Some farms have also seen the flow ($m^3/hr$) of their wells decrease and have difficulty in getting a drilling license for a new well since they refuse to pay their outstanding water bills.

Generally, as groundwater is still easily accessible in Azraq area (around 35 m deep), most farmers consider the water resource abundant ("it is like a sea down there" as some farmers mentioned, meaning the groundwater) and attribute the drying up of the Azraq wetland to the over abstraction of

[30] Highland farm survey 2008 – internal report – water focal point – Department of Land and Irrigation (MOA).

drinking water to Amman. They consider that the "special case for Azraq" (the clause in bylaw 85 that specifies a price for private agricultural wells within Azraq) in the water bylaw is unfair, and most refuse to pay their water bill: 12 out of the 36 surveyed farms have not paiyed their bills, most of which are large, recent farms. 5 farms did not provide information about their water bills, as the persons met during the interviews were the managers of the farms who are not responsible of paying the water bill, as bills are received by the owner. Among the 24 farmers who pay their water bill of the surveyed sample, there is a variability of the share of water costs out of global production costs of the farm: water accounts to 1 to 5% of the total production costs for 47% of the farmers; to 5 to 15% for 23% of the farms and, to 15 to 30% for 29% of farmers.

In addition to this, many farms contain illegal wells: there are 26 legal wells and 16 illegal wells within the surveyed farms. In the farms with illegal wells, the wells are not equipped with water metres to control water abstraction (even if most of them are numbered by WAJ); the bill is calculated based on the estimation of WAJ based on the cropped areas and the crop types. Some legal wells even are not equipped with water meters. Some farmers highlighted some inaccuracies in these estimations, as well as some inaccuracies in the procedure for land and well legalisation. For permitted wells, 250 $m^3$/du is not sufficient to sustain a farm, and all farms consume more than their free quota of water, except for 2 nearly abandoned farms.

Control over water abstraction has been quite limited in Azraq since the beginning of the development of agriculture, therefore it is now difficult for WAJ to apply the regulation and collect fees. Most farmers consider water to be a

Figure 4: Illegal well in Azraq: no meter is installed.

Figure 5: Meters installed on legal wells are used to calculate water consumption.

free resource, and argue that they already pay for energy, and that all water-related infrastructures are private investment (motor, pumps, drilling of the well(s), casing, connection to electricity when relevant), they should not pay for water over and above. But more than water fees, farmers worry over the price of energy. The share of energy costs out of the total production costs is always higher than that of water: 9 to 22% of total production costs are to be charged to energy for farms connected to electricity, and from 40 up to 82% for farms using diesel.

### 3.3.2. A more stable situation in North Badia and Jiza

In North Badia and Jiza, the situation is completely different. Nearly all wells are legal. In North Badia, most farmers consider that there is no specific water problem in their area, but are aware of the global water problem in Jordan. Only 3 farmers mentioned a water problem, as the water level dropped from 2 to 13 m in their wells. But the situation is much more worrying in Jiza, particularly Mwaqqar area. In Mwaqqar, the water table level has dramatically dropped in the last 10 years: water level dropped down by 35 meters since the founding of one of the farms visited (in 25 years), by 60 meters in another farm (in 20 years); another farm notices at present a drop of the water level in its well of 20 meters per year! The wells productivity also decreased for all wells in this area (only 25% of the initial flow for 5 wells). Some wells are therefore not sufficient anymore to irrigate the entire farm (mostly in Mwaqqar area) and farms are just kept surviving until the right price comes and the owners can sell the farms.

Since the year 2004, farmers have been receiving their water bills regularly: all surveyed farms paid their bills. Some farms do not receive any water bill as they consume less than the quota of 150000 $m^3$ (5 farms in Jiza, 2 farms in North Badia). Most of farmers try to reduce their water consumption; the reason being not to exceed the quota more than to limit water abstraction. Energy costs are always higher than water costs, even if all farms are connected to electricity, due to high extraction costs. For most of the farms, water costs are less than 10% of the total production cost, whereas energy represents on average 20 to 50% of the total production costs.

Some common dysfunctions to the whole basin regarding the application of the water law are listed below:

1. Some farmers have 2 wells on their farms: one well is legally registered in the WAJ official database as a working well, and water is billed to the farmer according to water meter readings for this well (or estimation of the consumption in some farms in Azraq). The second well is registered as non-working, but according to the field data, these wells are often used, at least

| Farming system | Large olive tree farms |
|---|---|
| Average superficy | 400 on average (from 100 to 640 du) |
| Picture |  <br>On his olive tree farm in Mwaqqar area, a farmer built 2 water-harvesting dams to save water |
| History of farms | Investors from Amman bought land in 1985 to 1995, when land was cheap, in Jiza and North Badia, partly for investment and partly to have a hobby farm.<br>Some owners use their farm as a prestige farm to invite guests. |
| Ownership | Owners are mostly from Amman, from Palestinian origin. |
| Type of crops | Olives |
| Legal status | Well and land are legal. |
| Use of water | All farmers have noted a reduction in groundwater level. It is especially in Muaqqar area that the drop of the water table (water level and flow ($m^3$/hr) delivered by the wells) is severe: wells are not sufficient any more to irrigate the farm. It has also to be noted that in this area, there used to be more precipitation, so irrigation was just complementary.<br><br>A farmer in Muaqqar built a water harvesting system to save water and does not need to pump from his well from March to June (average consumption from the well is therefore only 400 $m^3$/du/y).<br><br>Water consumption is on average 570 $m^3$/du/y for this category. It includes farms that have a water abstraction limited by the low flow delivered by their wells, and farms which wells deliver a high flow (and consume therefore more water, on average 800 $m^3$/du/y). |
| Source of energy | Electricity |
| Equipments and inputs | Farms are fully equipped with tractors and accessories. |
| Workers | 2 to 8 permanent Egyptian workers and extra seasonal labour are hired for the harvest (the production is not sold as dhaman) every year.<br>The management is delegated to a permanent worker on the farm (Egyptian, Sudanese). |

| Repartition of production costs | Average costs = 130 JD/du | % water cost | % energy cost | % labour cost | % input cost |
|---|---|---|---|---|---|
| | Average for all farms | 2% | 30% | 44% | 24% |
| Profitability | Average profit is 60 JD/du, but with a high variability between farms (negative for farms with water problems, 175 JD/du/y for the others). All owners have another source of income; some have other more profitable farm(s). | | | | |
| Remarks | Farmers who experienced the gradual drying up of their wells tried unsuccessfully to drill new wells. Today, it seems that they keep the trees alive only for the hope of being able to sell the farm (Muaqqar will soon be considered among the suburbs of Amman). | | | | |
| Representativeness of our sample | 1 out of the 14 surveyed farms in North Badia, 4 out of the farms surveyed in Jiza. This is representative of the reality, olive farms are not popular in North Badia. | | | | |

| Farming system | Small olive tree farm with diversification with livestock (chicken, cow, sheep) |
|---|---|
| Average superficy | 10 du |
| Picture |  These olive trees are 15 years old but are still very small as they suffer from a deficit in irrigation – Mwaqqar area, no well on the farm |
| History of farms | These farms have been bought in 1995s either by people from Amman to have a complementary income together with a hobby farm, or by bedouins who wanted to settle. Bedouins kept their herd of sheep and goat and planted a small orchard of olive trees; people from Amman planted olive trees, but realising it was not profitable (cf. water cost) they started cow or chicken farming. |
| Ownership | Most of the owners hired a permanent worker who is also the farm manager. For Bedouins, the family is living on the farm and managing it. |
| Type of crops | Olives |
| Legal status | Land is legal. There is no well on the land. |

| | |
|---|---|
| Use of water | As there is no well on the land, water is bought from neighboring farms for 0.7 JD/m³. As water is very expensive, consumption is reduced to the minimum (180 m³/du/y) and just allows olive trees to give little olives used mostly by the family.<br><br>Water accounts for more than 50% of production costs. |
| Energy | Diesel |
| Equipments and inputs | Equipment is minimum, work is done manually, and there is no tractor on the farm.<br>Farmers minimize the use of inputs to reduce production costs. |
| Workers | Only one permanent worker, or the family. |
| Profitability | Not profitable. |
| Remarks | These farms have suffered from the high increase in water price as they buy from private wells, and most of these farms are now not profitable, even after diversifying. Many farms are now being abandoned. |
| Representativeness of our sample | No farm of this type is found in North Badia. 2 out of the 9 surveyed farms in Jiza belong to this category. Our sample is greatly under representing this type of farms, but we were confirmed the same model applies for all similar farms. |

This typology of farming systems can be used to distinguish the impact of the governmental policy on different types of farms and to assess what could be the farmers' adaptive responses in each case.

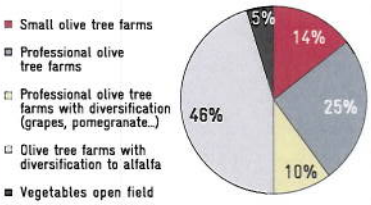
Farm types and their main characteristics in North Badia and Jiza are summarised in the table below:

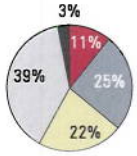
| Farm types | Average Farm Size | % of farms | % Total surveyed area | Average Water Consumption | Average Yearly Profit |
|---|---|---|---|---|---|
| Stone fruit tree entrepreneurs | 320 du | 13 % | 12 % | 1295 m³/du/y | 1000 JD/du/y |
| Family mixed farms vegetables and trees | 240 du owned +180 du rented | 48 % | 58 % | 1315 m³/du/y | 460 JD/du/y |
| Open field vegetable farms | 160 du | 8 % | 4 % | 1600 m³/du/y | 370 JD/du/y |
| Large olive tree farms | 400 du | 22 % | 25 % | 570 m³/du/y | 60 JD/du/y |
| Small olive tree farms with livestock | 10 du | 9 % | 1 % | 180 m³/du/y | No profit |

## 5.3. Repartition of water abstraction by farm typology

In Azraq, based on the estimated total area for each farm type and the average consumption by dunum, the following results have been found:

Repartition of water abstraction among farms types in Azraq



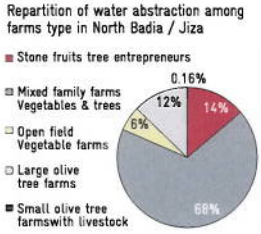



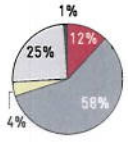

Irrigated agricultural area covered by each farm type in Azraq

These graphs show that some types of farms, especially olive trees farms with alfalfa and professional olive farms, are the main water consumers in Azraq (71% of the abstracted water) even if they represent only 41% of the farms. It should be reminded that it is mainly in these categories that farmers do not pay their water bills. In addition, most farms of the type olive trees with alfalfa are still working with diesel pumps, they are in a way trying to limit their water abstraction to limit the energy bill. Once they are connected to electricity, their pumping costs will drastically be reduced and we fear a high increase in their water abstraction. Highlighted here is the efficiency of water use of professional farms with diversification to fruits, which represent 22% of the irrigated cultivated land but consume only 10% of the abstraction water. It should also be noticed that juvenile olive tree farms, which represent 42% of the farms in Azraq, abstract only 14% of the water in Azraq.

In North Badia and Jiza, the same graphs show the following:

Repartition of water abstraction among farms type in North Badia / Jiza




Irrigated agricultural area covered by each farms type in North Badia and Jiza

Mixed family farms of vegetables and trees are large water consumers, consuming 68% of the total abstracted water while covering 58% of the irrigated agricultural area. In comparison, large olive tree farms achieve more water savings; using 12% of the abstracted water while covering 25% of the area. It can be explained based on the fact that the irrigation water requirement of vegetables and fruit trees are higher than they are for olive trees, and that farmers are often over irrigating their vegetables to overcome the salinisation of soils.