PLANNING FOR SCARCITY

Innovations in Water Management and Irrigation and the Future of Jordan River Valley

IDIN Fellowship Report

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PHOTOGRAPH BY PAOLO PELLEGRIN,
NATIONAL GEOGRAPHIC

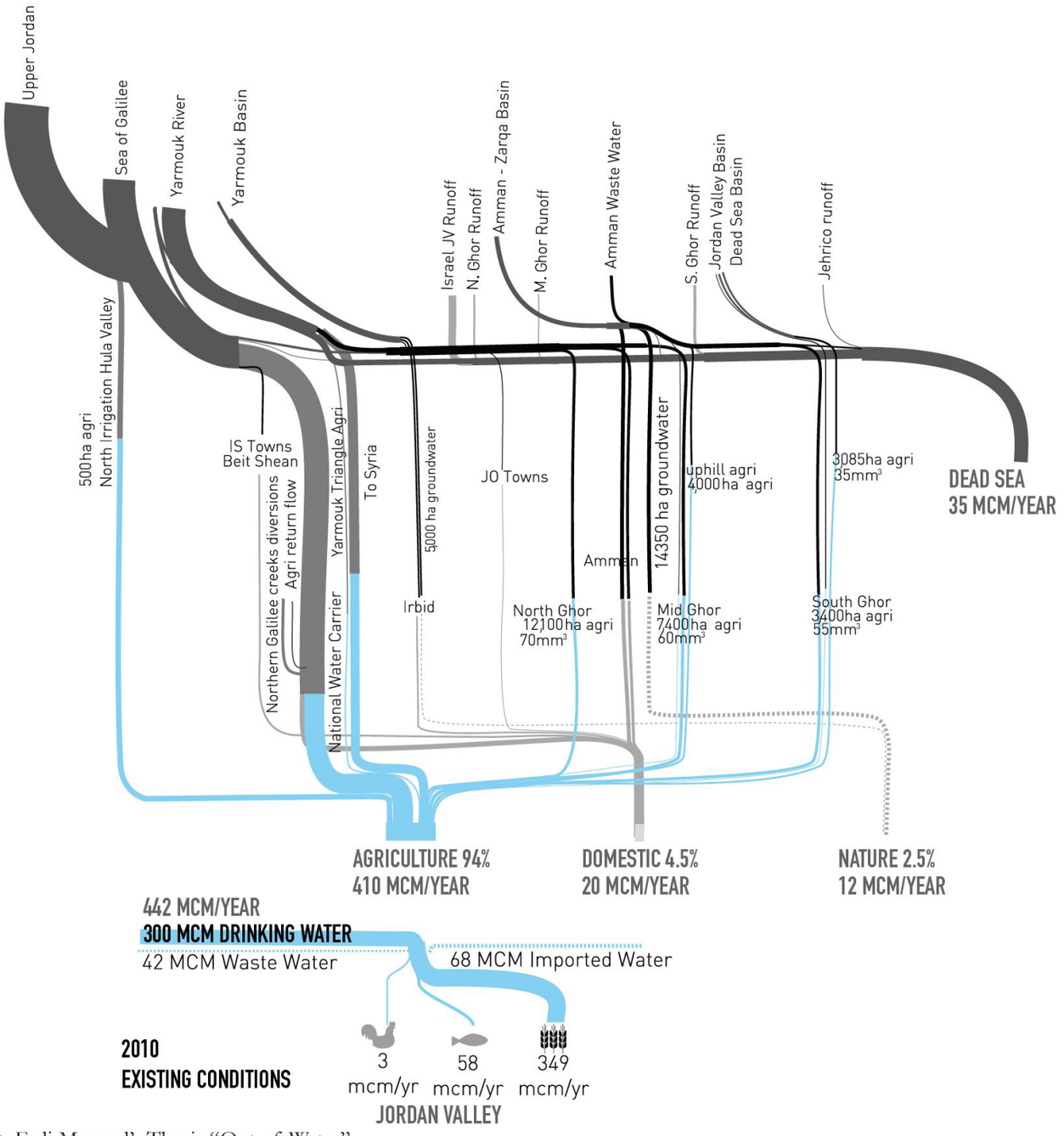
PART I. Background

Jordan Valley Today

Diversion & Pollution

Jordan ranks as the 3rd poorest nation in terms of freshwater resources at 133m3/person/year. Jordan produces around 880 billion cubic meters distributed over drinking household consumption and other economic activities and agriculture which alone consume 58% of total water. In 2015, Jordan faced a water deficit of 104.8 MCM per year (Hashemite Kingdom of Jordan, 2014). In the Jordan Valley itself, this number goes up to about 94%. As the Upper Jordan River flows south into Sea of Galilee, which provides the largest freshwater storage capacity along the Jordan River and winds further south through the Jordan Valley, Palestinians are denied any access to the water of the river. About a quarter of the 420 MCM Israel pumps from the Sea of Galilee goes to the local communities in Israel and to Jordan, the rest is diverted to Israel through the National Water Carrier (NWC) before it can reach the West Bank.

In the region at large, there is also a broader trend of an increasingly drying climate that raises further concerns about water availability in the Jordan Valley. The Mediterranean basin is one of the few regions where circulation models concur in their prediction of decreasing precipitation totals (Bates et al. 2008). In a recent study, scientists from the NASA Goddard Institute for Space Studies and University of Arizona analyzed 900 years (1100–2012) of Mediterranean drought variability and found that the recent 15-year drought in the Levant (1998–2012) was the driest in the record (Cook et al. 2016). Simulations show about a 10% decline in precipitation across the region by both the middle and the end of the century, with considerable variation between countries and international river basins (Chenoweth et al., 2011).

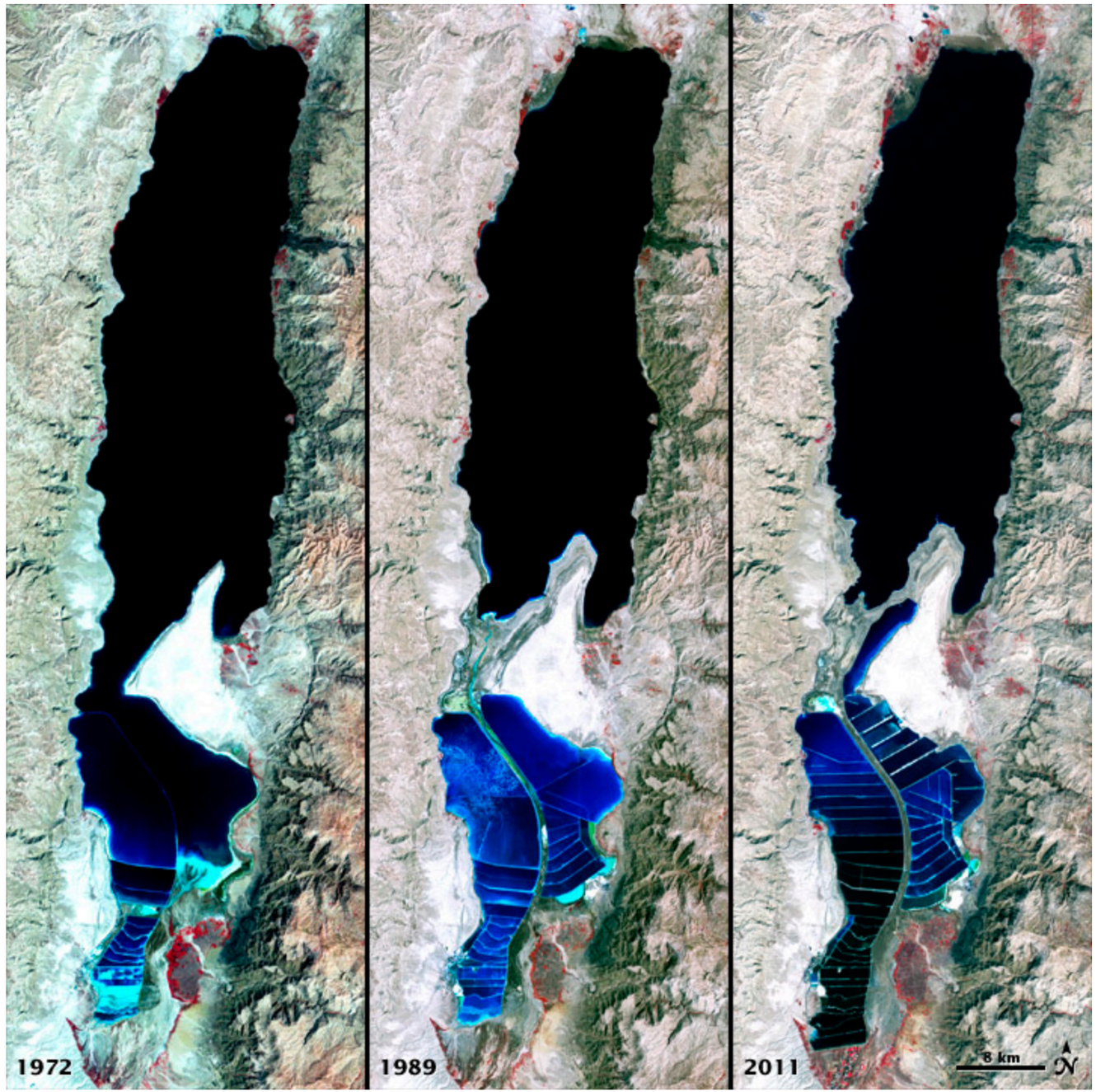


Credit: Fadi Masoud's Thesis "Out of Water"

Jordan Valley Today

Dessication of Dead Sea

Located in an area that receives less than 100 millimeters (under 4 inches) of rain per year and where temperatures often exceed 45°C, the Dead Sea is completely reliant on inflow for its continued existence. It is estimated that the total inflow to the Dead Sea has been reduced from around 1,250 million cubic meters (MCM) per year in 1950 to around 260 MCM per year in 2010. This has resulted in a 30% or more reduction in the surface area of the Dead Sea. About two thirds of the reduction in the Dead Sea's water level is due to this diversion of the water upstream by companies and farms in Israel, Jordan and Syria. The remaining 30 to 40 percent of the reduction is caused by the large mining companies in Israel and Jordan located in the southern section of the Dead Sea that transfer the water into evaporation ponds to make potash and bromine (Kool 2016).



Credit: NASA Observatory

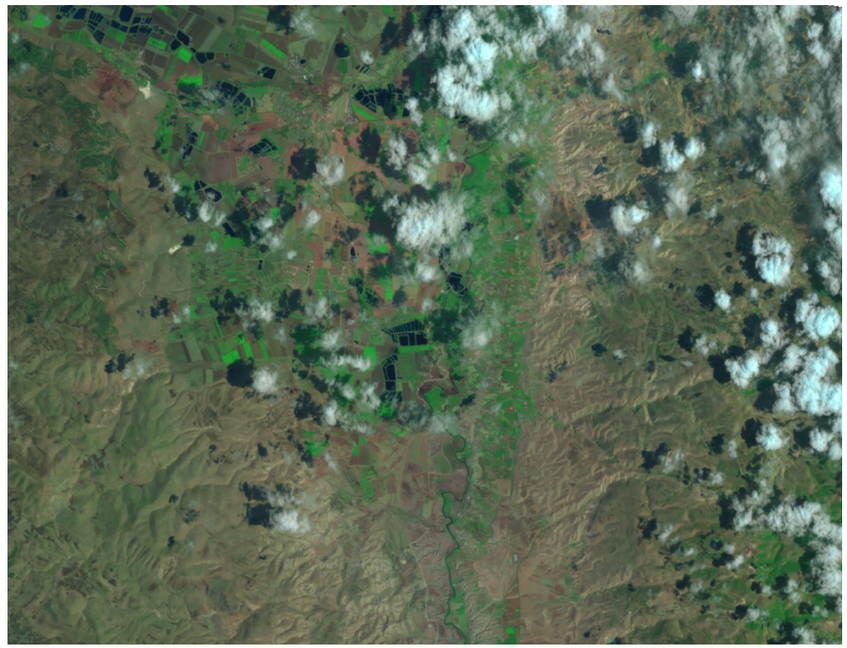
Jordan Valley Today

Land Use Change

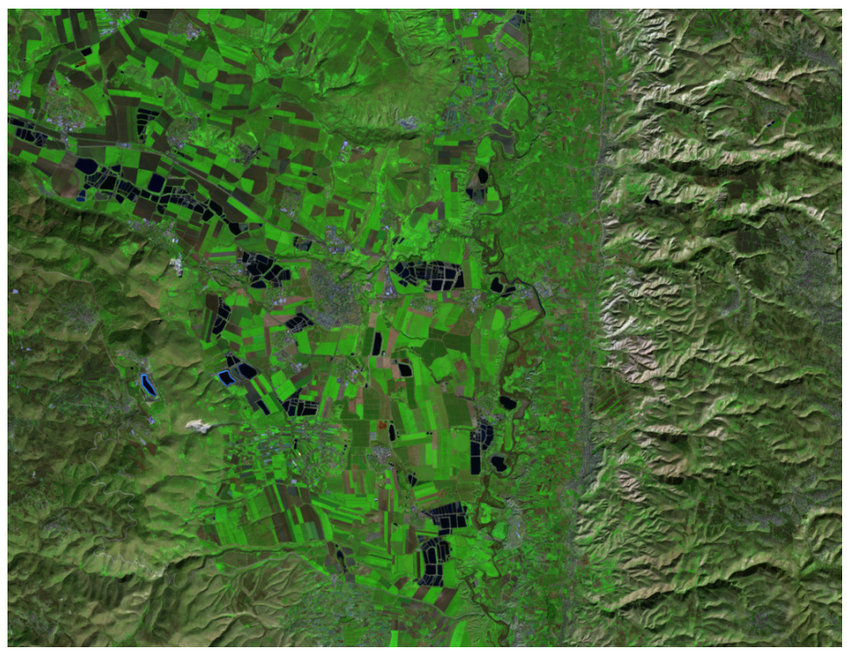
Approximately 600,000 people are living in the valley on both sides of the lower part of the Jordan River, including 55,000 Israelis (49,000 in Israel and 6000 settlers in the West Bank) 62,000 Palestinians, 247,000 registered Jordanians, and an estimated 250,000 foreign workers in Jordan, primarily from Egypt, Iraq, and (more recently) Syria. The Jordan Valley is the major agricultural production region for Jordan and Israel. 61.5 % of the area between the Sea of Galilee and Dead Sea consists of uncultivated land, with 32 % used for agriculture and 3.6 % as built-up area, defined as "space required for infrastructure and urban areas" (Kool 2016).

On a national scale Jordan's agricultural export, mainly fruits and vegetables, accounts for about 550 Million JOD (2014), mainly to the United Kingdom, The Netherlands, Canada, Germany, France, and to a lesser extend to the Gulf States. 20 % of Jordanians are employed in the agriculture, fishing, forestry sector. Israel is likewise a major exporter of agricultural products (accounting for about 2.2 Billion USD) as well as agricultural technologies. However the Jordan Valley plays a minor role in the agricultural production, since the bulk is produced in the central and western regions of the country. The diversion of water to irrigation agriculture, industry and domestic use has reduced the flow of the lower Jordan River to less than 2% of its original flow with the quality of water compromised by the seepage of sewage and agricultural runoff (Kool 2016).

As a result of reduced inflow from the Jordan River and mining operations in its southern banks and intensification of agricultural land use, the Dead Sea has lost more than a third of its surface over the past two decades. Data from the Geological Survey of Israel (GSI) shows that in 1976, the Dead Sea was at -398 meters below sea level, whereas in December 2015 it had reached almost -430 meters. The rate of recession is accelerating – in the first two decades since 1976, the water level dropped by 6 meters each decade, in the third decade it fell by 9 meters and in the last decade it plummeted by 11 meters. Sinkholes around the Dead Sea started forming around 1990 and in 2013, there were 4,336 sinkholes along the banks of the Dead Sea, with some of these craters having a depth of 80 feet (Hasson 2016).



Landsat 8: Jordan Valley in 1991



Landsat 8: Jordan Valley in 2016

PART II. Fieldwork

Interviews with Farmers

Innovations in Water Management and Irrigation in the Jordan River Valley

Research objective: *to document the range of challenges and barriers faced by farming communities in the Jordan Valley and to identify successful strategies adopted by farmers to maintain or increase yields in a context of water scarcity*

GENERAL INFORMATION

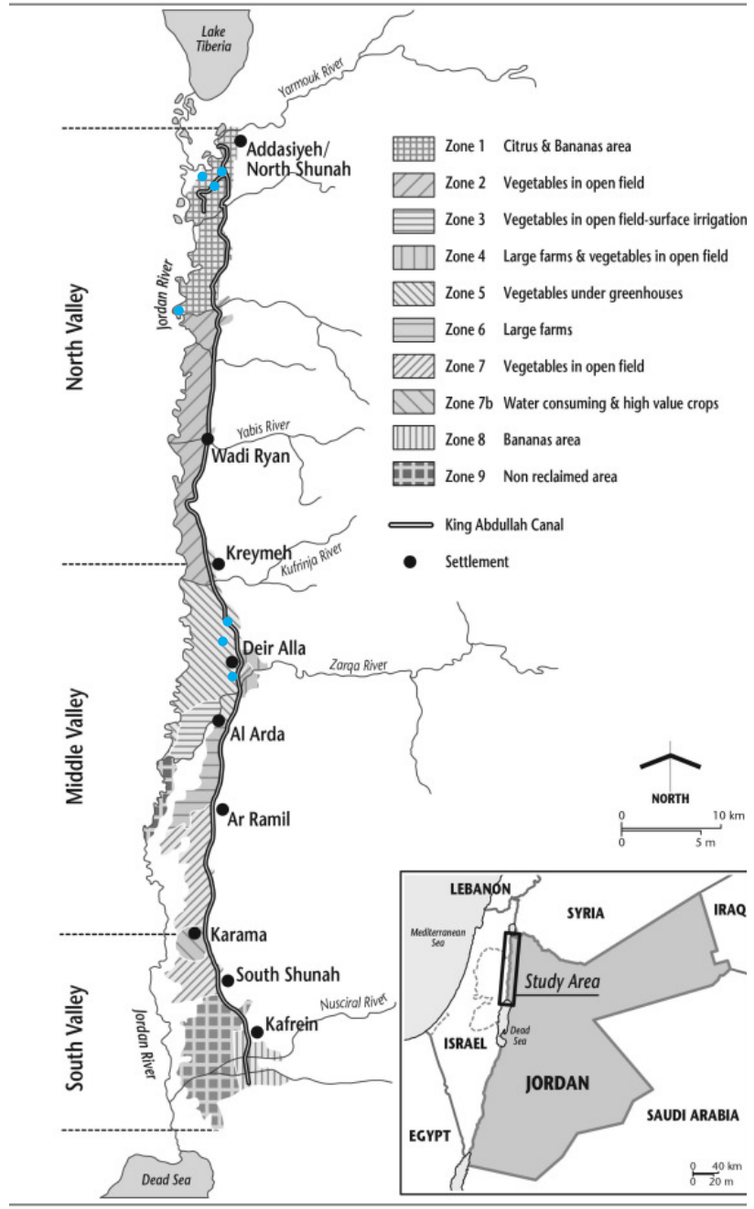
1. Which crops do you grow on your farm? Have you changed them based on water availability?
2. How long have you been farming here?
3. Have you expanded or decreased the size of your farmland over time?
4. What is the basic cost breakdown of running your farm? Which one has the potential of greatest cost savings?
5. How many other people help you with the management of your farm? Does this change from year to year?
6. Are you a member of a water user cooperative or similar community-based management organization?

IRRIGATION AND WATER CONSERVATION

7. What water sources do you rely on for irrigation?
    a.Public Irrigation scheme
    b.Retention pond
    c.Stream
    d.Motorized well
    e.Manual well
    f.Tank trucks
    g.Rainwater harvesting
    h.Reused greywater
8. On average how frequently do you receive public water? Do you supplement this with other sources?
9. How do you irrigate your farm?
    a.Basin
    b.Furrow
    c.Drip
    d.Other
10. Do you receive sufficient water to irrigate your crops?
11. What is the volume of water consumption in your weekly/ monthly water bill (m3)?
12. What, if any, water conservation measures do you use?
13. Do you store water on site? If yes, how many storage tanks do you have at your house? What is the total capacity of these tanks?

TECHNOLOGY AND DESIGN

14. What did you consider when designing the layout of your farmland? Have you changed it based on changing conditions over the years? If so, did you seek technical assistance?
15. Have you implemented new technologies in your farm that resulted in water savings?
16. Have you implemented new technologies in your farm that resulted in higher crop yields?
17. Are you satisfied with the overall condition of your farm?
18. What would you improve? Are these improvements related to new technologies, financing or other?



Findings

Farmer Profiles

Name	Muhammed
Location	North Shuna
Farming since	Parents started in 1920s
Crops	Citrus
Irrigation Method	Piped irrigation
Farm Area (donums) *1 donum = 1000 m2*	60
Volume of water (m3) received per week	500
Volume of water received per week per donum (m3/1000m2)	8.33
Biggest Cost Items (JD)	
Fertilizer	500
Pesticides	400
Employees	N/A
Other	N/A
Total	**3000**

Name	Motassem
Location	North Shuna
Farming since	Owns land since 2005
Crops	Citrus
Irrigation Method	Drip irrigation Water Pond
Farm Area (donums) *1 donum = 1000 m2*	70
Volume of water (m3) received per week	750
Volume of water received per week per donum (m3/1000m2)	10.70
Biggest Cost Items (JD)	
Fertilizer	7000
Pesticides	N/A
Employees	7000
Other	6000 for drip irrigation
Total	**21000**

Name	Raif
Location	North Shuna
Farming since	Parents started in 1920s
Crops	Avocado, Guava, Mango* *has been experimenting with develoment agencies like GIZ and JICA
Irrigation Method	Drip irrigation Water Pond Sensors for monitoring
Farm Area (donums) *1 donum = 1000 m2*	35
Volume of water (m3) received per week	500
Volume of water received per week per donum (m3/1000m2)	14.2
Biggest Cost Items (JD)	
Fertilizer	N/A
Pesticides	N/A
Employees	10000
Other	5000 for seeds
Total	**15000**

Name	Ali
Location	Sheikh Hussein
Farming since	1970s
Crops	Citrus, transition from bananas
Irrigation Method	Drip irrigation Water Pond Private Water Well
Farm Area (donums) *1 donum = 1000 m2*	32
Volume of water (m3) received per week	400
Volume of water received per week per donum (m3/1000m2)	12.5
Biggest Cost Items (JD)	
Fertilizer	1000-1500
Pesticides	2000
Employees	5000
Other	1800 electricity for pumping
Total	**10000**

Name	Rezaq
Location	Deir Alla
Farming since	2000
Crops	Vegetables (Tomato, Eggplant, Cucumber)
Irrigation Method	Drip irrigation Water pond Greenhouses
Farm Area (donums) *1 donum = 1000 m2*	28
Volume of water (m3) received per week	200
Volume of water received per week per donum (m3/1000m2)	7.14
Biggest Cost Items (JD)	
Fertilizer	N/A
Pesticides	N/A
Employees	7000
Other	4000 for seeds
Total	**16000**

Findings

Innovations in Water Management

Water User Associations

Community-based water management strated with the establishment of water user associations (WUAs), which began gradually in 2002 in a gradual fashion throughout the Jordan Valley Authority. Each WUA administers an area of land anywhere from 3660 to 15,735 dunums (1,000 sq meters = 10 dunums), or 56–374 farm units, with each farm unit covering roughly 35 dunums. Every WUA has a president, an official responsible for the technical distribution of water, and those who monitor the lateral lines and open and close them according to the water schedule. Membership in the WUA's general council, or main body, is voluntary. Raif Ebidawi in North Shuna was one such farmer.

Water Storage Infrastructure

Widely adopted technique for water stroage is the use of water ponds to store excess water throughout the week. Some water ponds are also used for fish farming. JICA has an initiative to encourage aquaculture in farms, which has been adopted by some of the farmers interviewed.

Treated Wastewater in Irrigation

Jordan has become one of the pioneer countries in the field of modern irrigation techniques and treated wastewater reuse. Jordan Valley Authority has undertaken integrated irrigation networks with wastewater treatment plants, leading to a wider reuse of treated wastewater in agriculture.

An advantage of treated wastewater reuse is the uptake of nutrients from treated wastewater, which has reduced dependence on synthetic fertilizers. Demonstration trials conducted jointly by GIZ and the Jordan Valley Authority show that each farm unit (35 donum) can save JD1000 – 3000 annually on fertilizer expenses, which is equivalent to no less than JD4 million countrywide.

Hydroponics

Programs such as the USAID Hydroponic Green Farming Initiative (HGFI) and the Dutch Embassy in Amman are responding to water use efficiency problem in irrigated agriculture through programs to promote hydroponics in Jordan. While the intention of these programs is to introduce the technology to farmers and vulnerable groups, such as women and youth, my fieldwork suggests that sich technologies are not widely adopted due to the poor quality of water farmers are receiving from canals. One farmers in Deir Alla, Rezaq, mentioned that although he would be interested in the technology, the high salinity of irrigation water he receives is not suitable to grow vegetables hydroponically.

PART III. Geographic Data Anlaysis

The Site

Irrigation Network

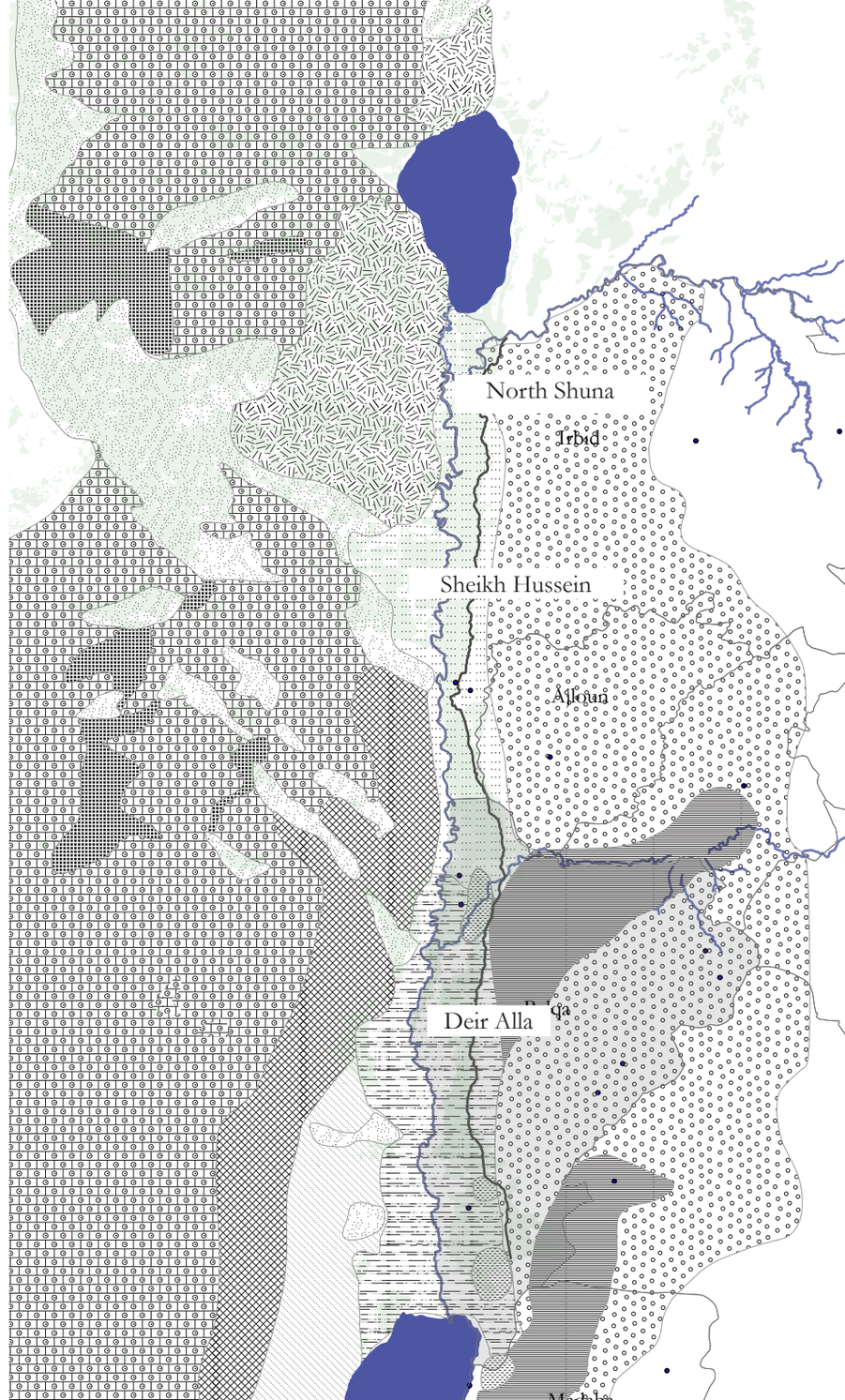
— King Abdullah Canal

● Wastewater Treatment Facility

Source: JVA

The Site

Soil Analysis



Terra Rosa and Rendzinas

Sandstone and Granite Sands

Hammada Plains

Saline Soils

Lissan Marls (Non Saline)

Basalt

Terra Rosa

Dark Rendzina

Calcareous Steppe Soils

Hammada like Rocky Deserts

Source: JVA, Zohary

Next Steps

Challenges Ahead

Climate Adaptation and Responding to Chronic Droughts

With the existing climate change scenario, almost half the world's population will be living in areas of high water stress by 2030, including between 75 million and 250 million people in Africa. In addition, water scarcity in some arid and semi-arid places will displace between 24 million and 700 million people. Analysis of the impacts of climate change has been made for the wider Middle East Region such as GLOWA foresee a reduction in local annual water resources of 20 % by 2050 and increasing temperatures and related surface water evaporation rates.

The effects of the 2007-2010 drought were most acutely felt in northeast Syria, where wheat and barley yields dropped by 47% and 67% respectively, many herders lost over 80% of their livestock, and numerous farmers in the region suffered from total or near total crop failure in the following season (ACSAD 2011, UNOCHA 2010). Iraq was also severely affected by the drought, as crop yields declined through the country's cultivated areas and wheat production fell by 45% in 2008 from an average harvest. The lower Jordan River Valley suffered some losses in the beginning of the 2007–2010 drought as well—yields of main crops including wheat, olives, grapes and other fruits decreased by 35%-40% relative to an average harvest (Abdo, 2014). Therefore, in my thesis research in urban and regional planning, I will develop a two-pronged approach to sustainable development in the Jordan Valley based on interviews with government officials and experts.

I. Ecological Restoration

a. Water and Sanitation Infrastructure

- Indentifying underserved areas in terms of water supply
- Indentifying polluted areas
- Addressing increasing salinity in Deir Alla region

b. Remediation and Landscaping

- Terra forming for continuous drainage
- Pyhtoremediation methods
- Traditional farming methods: Terrace farming and ancient runoff irrigation

II. Land Use Change and Alternative Livelihoods

a. Land Conservation

- shifting away from agriculture in areas with poor water quality and high salinity
- employing the concept of virtual water for crop planting

b. Alternative Livelihoods: Value Added Farming

- Light manufacturing: processing produce
- Agro-tourism