THE WATER SKIRMISH

Identifying stakeholders while using optimal water allocation models to resolve conflicts in Jericho City

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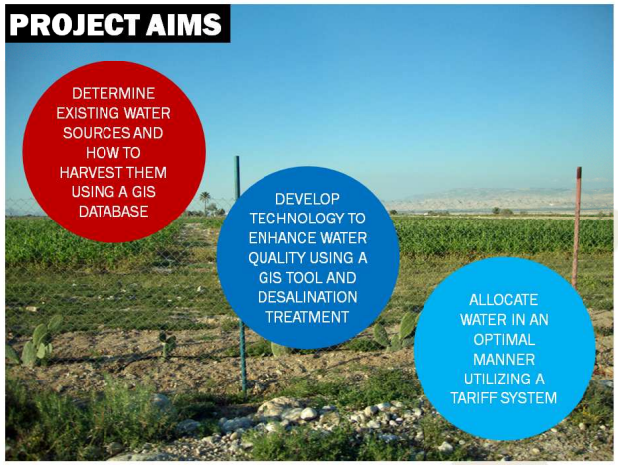
MOTIVATION

- Ein Al-Sultan, the main water resource for Jericho City, Palestine (Figure 1), is currently facing stress due to the water demands of the region.
- Consumption of water in Palestine is typically 70 liters/capita/day, well below the 100 liters/capita/day recommended by the World Health Organization.
- Palestinian Hydrology Group has projected that by 2023, all spring water resources will need to be allocated to the domestic sector, leaving the agricultural sector solely dependent on available groundwater from saline-contaminated wells.
- Brackish well water in Jericho City has salinity levels in excess of 2000mg/L above the tolerance range of 200-1500mg/L for locally grown crops, necessitating a treatment process for irrigation.
- Jericho City also faces internal conflicts of interest among stakeholders, namely the Palestinian Water Authority and Agricultural Union.
- A water pricing model is needed to ensure equitable distribution among these competing interests.

FIGURE 1. MAP OF JERICHO CITY AND THE OCCUPIED PALESTINIAN TERRITORIES

PROJECT AIMS



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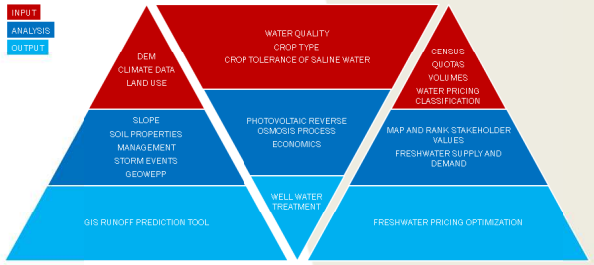
DESIGN FRAMEWORK



RESEARCH IN PROGRESS

GIS RUNOFF PREDICTION TOOL

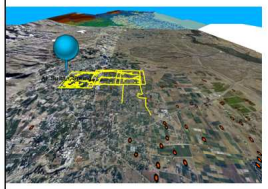


FIGURE 2. 3D MAP OF PRIVATE WELLS IN JERICHO CITY

- Compiled data layers in GIS overlayed upon aerial photographs highlight topography and infrastructure that affect water treatment and distribution in Jericho City.
- In addition to salinity, soil erosion also degrades water quality. A surface runoff and soil erosion prediction tool using data extracted from GIS can facilitate improvements in management practices of cropland.
- Comparing our results with GeoWEPP and other modeling tools used by PHG tests the validity of our methodology.

PV-RO WELL WATER TREATMENT PROPOSAL

- Private wells are not linked to the water distribution network supplied by Ein Al-Sultan (Figure 2), which implies that farmers outside the network rely exclusively on these wells to irrigate their crops.
- Farmers are limited to growing only crops that can tolerate the high salinity levels of the groundwater being pumped from the wells.
- A photovoltaic reverse osmosis (PV-RO) desalination treatment system has the highest efficiency rate of removing salinity, and is the most economically feasible system applicable to Jericho City.
- Treated water can enable farmers to become more self-sustainable by growing a variety of crops without relying on the municipal system.
- Evaluation of commercially-available desalination treatment systems can be found in Table 1. The selection of a system is based on the specific parameters (Figure 3) of each individual farm.

Company	System	Cost	Capacity (m3)	Threshold of treatment (PPM)	Useful Life (years)
Spectra Watermakers	SSBW 11000	50k-60k	11	10,000	15
	SSBW 15000	70k-80k	15	10,000	15
Millennium KI	MMP-TRK 6	53,000	5.6	14,000	20
	MMP-TRK 9	68,860	12	14,000	20
	MMP-TRK 16	92,000	23	14,000	20
MaxPure	Brackish Water	90k-100k	19	10,000	15-20

TABLE 1. COMMERCIALLY AVAILABLE PV-RO DESALINATION TREATMENT SYSTEMS

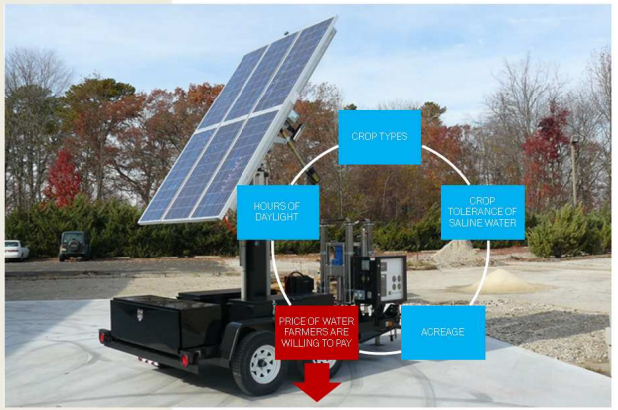
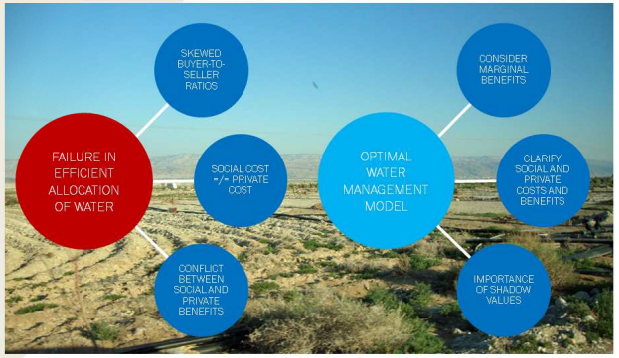


FIGURE 3. MILLENNIUM KI MMP-TRK 9 WATER TREATMENT SYSTEM AND THE SPECIFIC PARAMETERS NEEDED TO CHOOSE THE MOST RELEVANT TREATMENT SYSTEM

TARIFFS AND WATER PRICING

The water problem in Jericho City is exacerbated by the lack of regulated water pricing and allocation systems. Further, the social value attached to water, especially in an arid area like this, lends a unique dimension to the water problem.



A semi-welfarist approach to a modified "Coase" tariff system proposed by Meran and Hirschhausen (2009) is recommended to address the lack of regulated water pricing and allocations in Jericho City. It is based on the principle that poor people cannot afford water supplied at marginal costs and pay fixed access fees. The equations that model this is as follows:

$$T(y) = \underline{y} + \alpha(y - \underline{y}) \qquad w(y) = w_s + \alpha(y - \underline{y})/[(1 + m)c]$$

where
T(y) – Continuous Outlay of Customers
α - Elasticity factor
w(y) - Profile for water consumption
w_s - Subsistence level of water
y - Income level
$\underline{y}$ - Minimum Income
m - Uplift factor

REFERENCES
Fisher, F. (2002, November). Optimal water management and conflict resolution. *The Middle East Water Project*.
Meran, G., and Hirschhausen, C. (2009, June). Increasing Block Tariffs in the Water Sector. *A Semi-Welfarist Approach*. Berlin.