Deployment of Technology to Mitigate Drought Risk in Syria

By Nicholas Zimmermann, Candidate for Master's in Urban Planning, 2014, Harvard GSD

How can technology be leveraged to ease chronic water shortages in Syria and its surrounding region? For potential applications of technology that are both expensive and highly localized, how should sites be prioritized to maximize future gains in anticipation of climate change projections?

This paper will explore geospatial and statistical data on the relationship between water and human settlement in Syria, and what potential opportunities technology may offer to offset ongoing deficits in water resources. Estimating the suitability and potential benefits of technologies, regardless of the particular region or country will require careful analysis of local conditions. In addition to considering cultural and economic environments, I will compare and analyze elements of land use, hydrology, climate, and human settlement, drawing from Geographic Information Systems (GIS) datasets to the extent that they are available. Drawing on geospatial data will be essential to establish effective strategies for choosing sites to focus on across a broad, diverse region. By assigning priority based on atmospheric conditions, demographic trends, and projections of future climate scenarios, the analysis will seek to establish locations that present the greatest needs and offer the clearest opportunities for intervention.

Since drought is a recurring and pervasive hazard in arid countries, its disruptive effects influence a broad spectrum of social and economic sectors. There are a multitude of variables one could consider as criteria to establish priorities, and so the index used here is only one of many possible ones. Another strategy could be based on the political landscape, both regional and domestic, which is particularly high-profile in the Middle-East. Water resources are hotly contested and defended in virtually any context of human settlement, particularly in arid regions where the resource is naturally scarcer. In Syria, where socio-political turbulence has recently exploded into catastrophic internal conflict and war, well beyond regional water concerns, more basic features of transportation, infrastructure, and security add new and unpredictable logistical challenges to the prospects of technology transfer.

However, although the political history and ongoing tensions are built-in factors for many of the social and economic indicators of the region, this study aims to keep political factors at a distance, focusing instead on physical features and projections of climate and population over the next several decades. Climate projections are assumed to be more reliable than any speculation about the future political atmosphere, such that drought will almost certainly remain a serious risk in the future, particularly at the sites analyzed here.

Research began with a survey of economic, climatic, and demographic indicators for the region (defined here as Syria, Lebanon, Jordan and Israel. The West Bank and Gaza are sometimes included in datasets, although often they are not). Syria came to be the focus of the study later on, when geospatial data about settlement density and climate change projections were factored in during site analysis, and confirmed through a review of other research covering the region.

Several statistics about the broader study region stand out as remarkable. First, the average population growth rate for the four nations is 7.9%, far higher than the global average of 2.6% (WPP 2012). Most research on water security and drought in the region make note of the urgency that this growth rate entails. Another striking feature of the region, and particularly Syria, is the relationship between the agricultural sector and water consumption. In Syria, agriculture contributes

about 18% of GDP and 17% of the labor force (CIA 2013). The agriculture sector is also responsible for 90% of its total water consumption, an amount projected to amount to a 5 billion cubic meter water deficit by 2025 (Al-Riffai, 26). Syria's total renewable water resources were estimated to be 16.8 billion cubic meters in 2011 (CIA 2014). It is clear that consumption is outpacing reserves, particularly in the context of growing population and expected rise in drought conditions.

Surprisingly, half of Syrian agriculture lies in a relatively narrow band of land, and is primarily rain fed. The distribution of cropland is derived from a 1977 collaboration between the Syrian government and the International Center for Agricultural Research in the Dry Areas (ICARDA) (Pala: 2003). Wheat is Syria's most important crop, for food as well as for export, but it requires a certain amount of water (typically 300-500 mm/yr) in order to survive. The land is therefore zoned, and the zones in the northeastern regions, defined as 1a, 1b, and 2 by Syria and ICARDA, receive enough precipitation annually to be suitable as cropland for wheat. Only zone 1 is reliable as land for rainfed crops. (Al-Riffai 26).

The fact that so much of Syria's agricultural base is rainfed suggests two points. First, considering the amount of water dedicated to agriculture, the process must be far less efficient than previously assumed for land which is irrigated. Second, projected changes in precipitation based on climate change models raise serious questions about how reliable that land will be in the future for rainfed production. If irrigation were ramped up to fill that deficit, the stress on already precarious reserves of water would rise sharply. As alarming as the ratio of consumption to resources may be, the staggering inefficiency of current methods means that the potential for improvement is enormous. The most obvious way to improve efficiency is to implement widespread water treatment technology, such that wastewater can be reused. According to one estimate, Syria stands to gain up to 450 million cubic meters per year in recycled wastewater (Comair et al 2012). This could be done if water treatment systems were available, since they are required to remove salinity, pathogens, and toxins. 450 million cubic meters, the estimated savings, is about one third of the annual amount of water consumed for domestic uses.

The study is thus based on these three assumptions:
1. Rainfed cropland in Syria is important for national food stocks and GDP.
2. As it is dependent on rainfall, these regions face the predicted threat of an increasingly arid climate.
3. There is great potential for reducing overall consumption by recycling treated wastewater for agriculture.

One possible solution is the introduction of water treatment technology, to achieve the goal of recycling wastewater as much as possible. Although large, municipal treatment facilities would be ideal for some locations, they require significant investment. Further, they may not be appropriate for rural agricultural settings. Instead, this study proposes small to medium scale mobile water treatment units as an alternative to large plants. These units have typically been used in post-disaster settings, such as following earthquakes or floods, but they have great potential for permanent use in some of Syria's most threatened areas.

To identify suitable locations for mobile water treatment units, a GIS analysis geospatial data considered the following traits:

- Is the settlement rainfed or irrigated? (Based on the Anthropogenic Biomes of the World dataset, produced by SEDAC and CIESIN, Columbia University).
- Is it undergoing population growth at a greater rate than the global average?
- Is it projected to be significantly affected by climate change in the next 20 years? (25% seasonal change or higher)
- What is the elevation of the site? The idea here being both that water consumption upstream receive higher priority than downstream conservation, not only for volume but to reduce upstream contaminants.

After reviewing many other variables and features, three sites were selected as possible locations to pilot the first wave of a mobile water treatment program. These are Idlib, Jisr al-Shughur, and Slanfah.

Common features of the sites include:

- Each of the three sites is within agro-ecological zone 1.
- Each site is rainfed.
- Each site sits at an altitude of 500 meters or higher.
- Each site is estimated to experience population growth at a rate that exceeds the global mean.
- Each site is expected to be significantly affected by climate change, based on the B1 and A2 projection models.

To explore various potential roles of mobile water treatment technology, and how use might vary with scale, the three sites vary in population. Idlib is just under 100,000, Jisr al-Shughur is about 44,000, and Slanfah is estimated to be 15,000. For larger cities like Idlib, water treatment units could either be deployed in multiples around the perimeter, or if large enough, directly as municipal infrastructure. For Jisr al-Shughur and Slanfah, water treatment units could be concentrated around agricultural sectors. Jisr al-Shughur lies along the Orontes River, providing an example case where mobile treatment units could be adjusted to boost potable water supply if groundwater reserves ran low, as they are expected to.

There is growing market of firms that design and produce water treatment technology, and if climate predictions for arid regions prove accurate, that market will continue to grow. A report by Bloomberg listing companies providing treatment systems by country of origin shows the U.S. as dominant in the marketplace, followed by Germany and China. However, 19 countries are represented in total, suggesting that future growth could be geometric. Although obviously limited in capacity, mobile units are in a different order of price from millions of dollars demanded to erect treatment plants. Many units providing around 6,000 liters per hour now cost between USD $20-40,000. Since not every country can afford to follow Israel's example and build four desalination plants (Tal 2013), mobile water treatment may be a realistic way to meet a critical need, as a transitional step toward more permanent solutions. If arid conditions worsen, and drought becomes more severe and more frequent, it may be the only option available.