The Consequences of Water Scarcity:

ASSESSING IRRIGATED AGRICULTURE IN NORTHEASTERN SYRIA USING SATELLITE IMAGERY

INTRODUCTION

Water scarcity has been ranked most critical issue in our society today. The challenges of water scarcity are acutely felt in agriculture, which today accounts for approximately 70% of the world's freshwater withdrawals.

The Khabur River Basin in northeast Syria is an obvious example of an agriculture-dependent area constrained by access to reliable water supplies, and facing severe water shortage obstacles in the future.

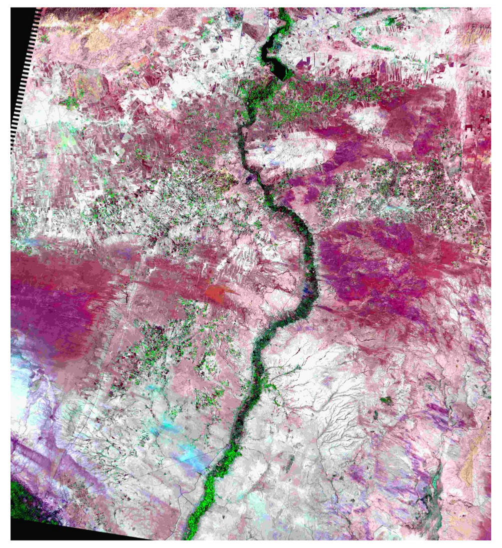
The impact of drought on rainfed crops is often hugely detrimental, as this type of agriculture is very reliant on timely rainfall during the growing season. This was evidenced by the massive crop failures in non-irrigated areas that occurred throughout the northeast region of Syria starting in 2006. However, the impact of precipitation shortages on irrigated crops, which are purposed to be resistant to variability in precipitation, is less certain.

OBJECTIVE

To assess the vulnerability of irrigated agriculture in the Lower Khabur River Basin to variability in rainfall amounts over the period from 1999 to 2011, as well as the relationship between the amount of irrigated areas and water levels in the southern part of the Khabur River, using Landsat imagery and remote sensing techniques.

METHODOLOGY

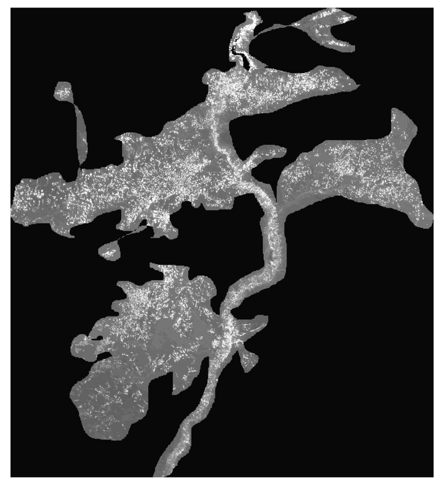
1. DATA COLLECTION | Landsat TM CDR images covering the southern portion of the Khabur River Basin (path 171, row 35) were acquired from USGS Earth Explorer for the years 1999, 2000, 2003, 2006, 2007, 2009, 2010, and 2011, each taken in August or September, the driest period of the year, when all productive, agricultural areas are irrigated. Annual rainfall accumulation data in this region for these years was taken from the TRMM satellite using the TRMM TOVAS dataset.



2. NDVI THRESHOLDING | Irrigated agriculture pixels in the region of interest were computed in each image using the Normalized Difference Vegetation Index (NDVI) using ENVI. Pixels outside of the "productive crops" threshold (0.2 to 1) were masked, with unmasked pixels representing "productive crops".

3. DENSITY SLICING | Water pixels of the Khabur River were computed using the Density Slicing tool on Band 5 (mid-infrared). A range for pixels in the region of interest was selected on a histogram of pixel brightness to identify water, and a second range was made for all other land cover.

4. LINEAR REGRESSION | Correlations between irrigated agriculture and rainfall, as well as between irrigated agriculture and water in the Khabur were determined using linear regression in Microsoft Excel.



NDVI Band

NDVI Threshold Mask

Band 5 Grayscale

Class Image of Density Slice Ranges

RESULTS

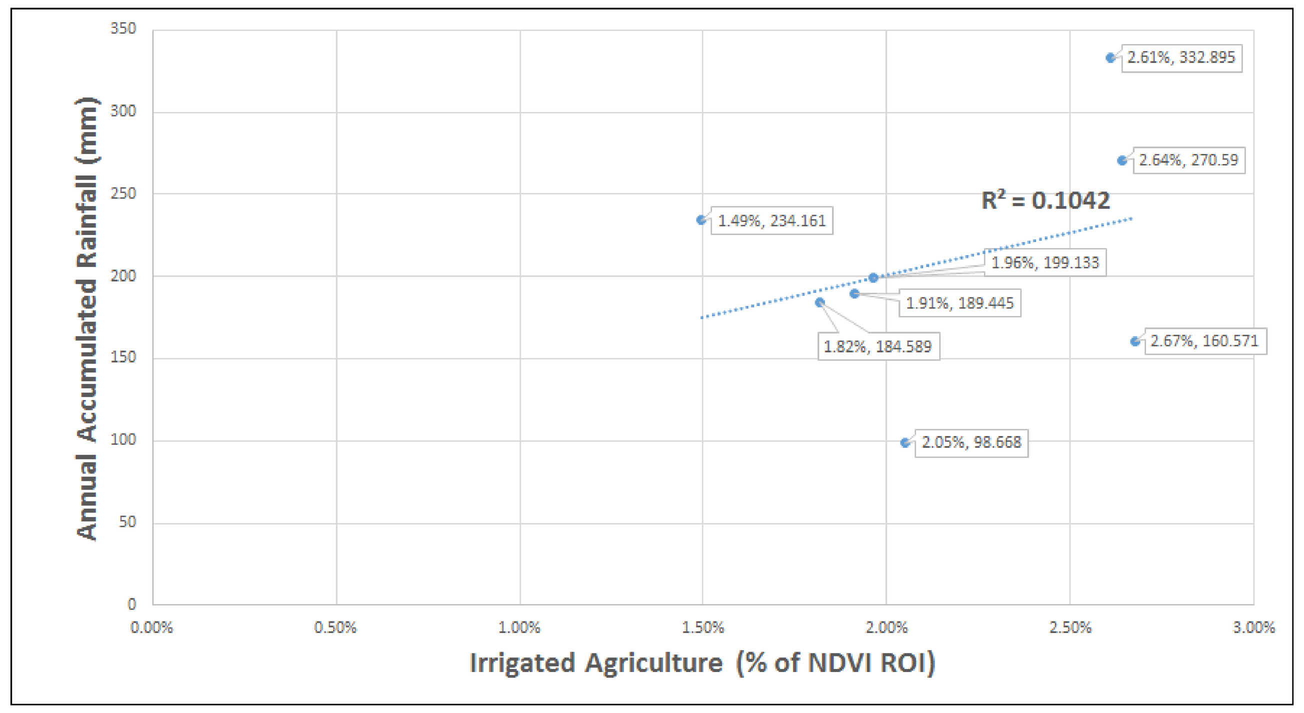


Figure 1

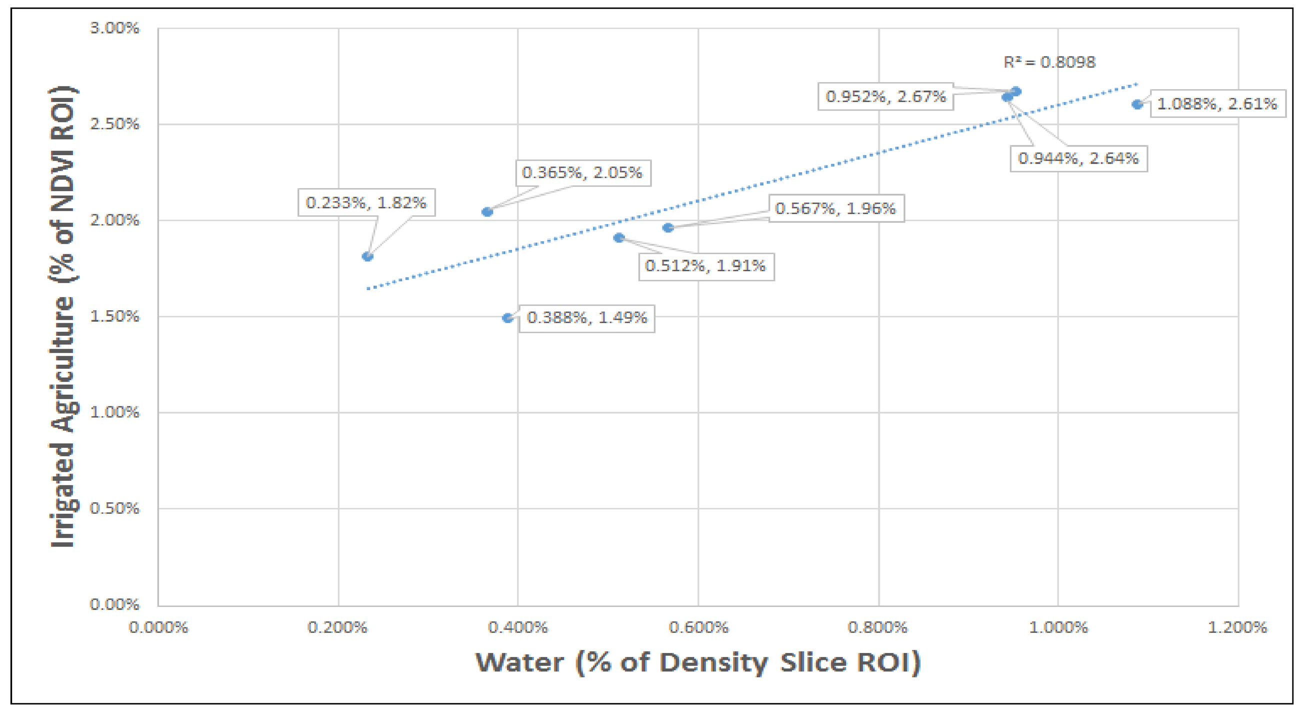


Figure 2

The R-squared value obtained from the linear regression analysis between the percentage of irrigated areas and the amount of rainfall (**Figure 1**) was 0.10—10% of the variation in this relationship can be explained by the linear model.

The R-squared value obtained from the linear regression analysis between the percentage of irrigated areas and the percentage of water (**Figure 2**) was 0.81—81% of the variation in this relationship can be explained by the linear model.

CONCLUSION

The weak correlation between the rainfall and irrigated agriculture could be explained by a number of different factors, both within the remote sensing techniques used and on the ground.

Groundwater irrigation is one explanation. The productivity of these crops may not be as much dictated by rainfall as it is to the ability of groundwater wells to continue to extract water reliably, resulting a weak correlation between healthy irrigated agriculture and rainfall amounts. Additionally, the single-date NDVI calculation for each year does not account for the possible variation in planting times that may have occurred in this region.

The strong correlation between irrigated areas and water in the Khabur river was contrary to expectation. The Syrian government has pursued aggressive water development projects, especially in groundwater extraction, resulting in significant lowering of the water table in the past decade. If irrigated agriculture was using groundwater extraction to supply crops, then the lowering of the water table in this area would mean less water in the river, especially downstream. It may be that different irrigation techniques besides groundwater irrigation, such as flood and canal irrigation, both of which are highly dependent on the amount of surface water available in the area, were used.

FUTURE DIRECTIONS

This project was hindered in many ways by a lack of access to ground-truth data that would have aided in accuracy assessment of the study. Access to provincial statistics for agriculture, information of crop growth schedules, and rates of discharge in the Khabur River would be useful for further research.

Next steps of this study involve mapping irrigated areas and determining how they change in terms of their location and their productivity over a given time frame depending on the amount of rainfall, availability of water, and introduction of new irrigation technologies to the area.

It is the hope that the results of these investigations can be used to inform agricultural policy and drought mitigation strategies in Syria.

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CEE 154: Introduction to Remote Sensing, Alexander Liss

Data Sources: USGS Earth Explorer, TRMM TOVAS Dataset

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