environmental sciences proceedings

MDPI

Proceeding Paper

Studying Correlation between Precipitation and NDVI/MODIS for Time Series (2012 - 2022) in Arid Region in Syria †

Rukea Al-hasn *

Natural Resources Research administration, General Commission for Scientific Agricultural Research (GCSAR), Damascus, Syria
* Correspondence: rukeaalhasn@gmail.com; Tel.: (+963947767520, Alhasn, Th. R.)

† Presented at the 5th International Electronic Conference on Remote Sensing, 7–21 November 2023; Available online: https://ecrs2023.sciforum.net/

Abstract: Vegetation degradation is correlated with drought. The more drought intensifies, the more degraded vegetation increases. Therefore, this study aimed to assess the correlation between rainfall and changes in the Normalized Difference Vegetation Index (NDVI) under arid and semi-arid conditions in Syria. The study was carried out using annual rainfall data for (2012-2022) obtained from the Agricultural cloud seeding Project, to determine the average rainfall of the study area and to link it to the NDVI index of MODIS image data processed using the Google Earth Engine (GEE) for April of each year for the same time series. The results showed that the lowest NDVI value (0.098) was in (2016), representing the driest year during the studied series, while the highest NDVI value (0.24) was in 2019, which coincided with the highest rainfall rate of 206.67 mm, thus representing the less arid year during the same series. It also found a strong correlation (R=0.7) between the overall average rainfall and the overall NDVI values of the studied time series. The study has shown that changes in the NDVI index are associated with changes in rainfall, indicating that they can be used to estimate and study drought as a simple method derived from satellite data in isolation from ground data.

Keywords: NDVI; rainfall; drought; correlation; MODIS; GEE

1. Introduction

Many difficult climatic factors have dominated the Middle East region recently, most notably drought [9]. Syria in particular is considered one of the most economically areas to drought. Which negatively affected agricultural areas and their productivity, which led to the exit of a large portion of agricultural areas from the production process, especially rain-fed agriculture [1].

Low rainfall negatively affects the agricultural and livestock sectors, requiring limited quantitative and qualitative use of available water [4]. The sensitivity to drought is also increasing in the eastern region of Syria as a result of the growing population and the subsequent increase in demand for water resources and the deterioration of natural pastures [5].

On the other hand, Remote sensing technologies play a major role in the agricultural and climatic fields, such as monitoring climate changes, the growth of agricultural crops, and studying different patterns of drought, which has prompted an attempt to employ this data in the drought monitoring process [10].

2. Objectives of the Study

Citation: To be added by editorial staff during production.

Academic Editor: Firstname Lastname

Published: date

This study aimed to evaluate the relationship between rainfall amounts and changes in vegetation areas in conditions of arid and semi-arid regions represented by Deir ez-Zor Governorate.

3. Materials and Methods

3.1. Study Area

The total area of the governorate is 33.06 thousand km², occupying 17.9% of the country's area. It is extends between the longitudes of (39°° 14' 36" - 41º 13' 7") east, and latitudes of (36˚ 20' 23" - 33º 7' 29") north. Its average height is 220 meters above sea level As seen in (Figure 1).

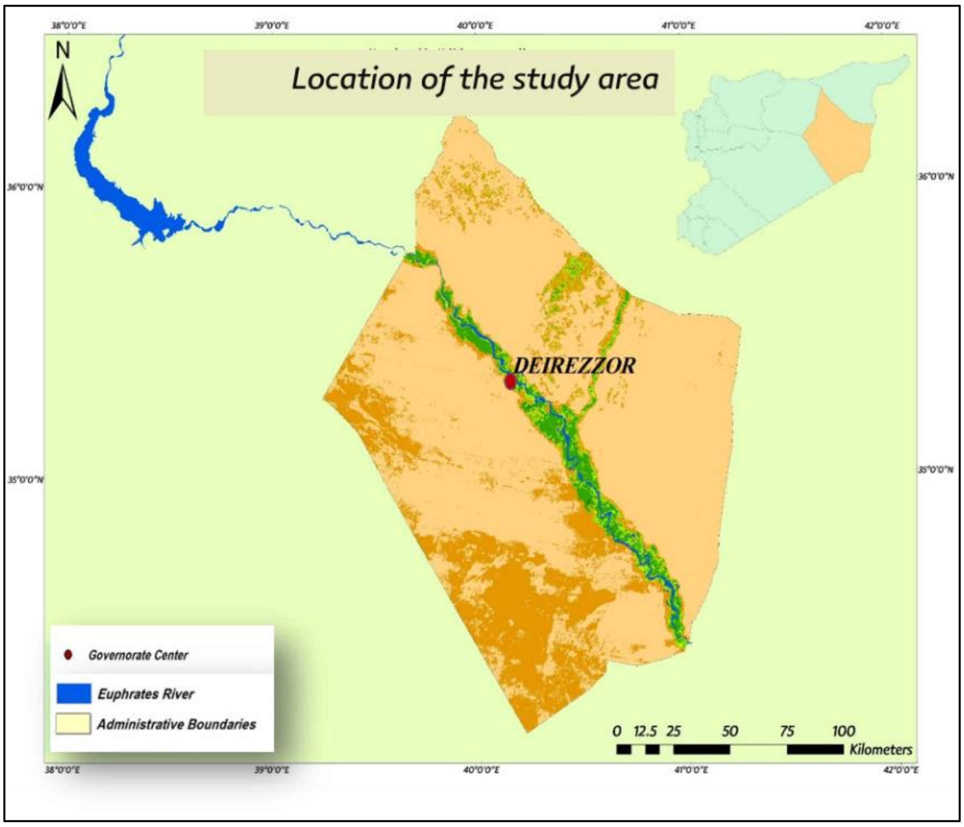

Figure 1. Location of the study area.

3.2. Climate of the Study Area

The climate of the study area is Mediterranean with a continental influence, and climatically it is classified into semi-arid, arid and extremely dry regions according to the Amberger classification. It is characterized by a long dry season extending from June to October, and a cold winter with an average rainfall of 160-200 mm annually [3].

3.3. Data

3.3.1. Satellite Images

NDVI images from MODIS (Terra/Aqua) satellite data were used for the time series from 2012 to 2022 (11 years) for April of each year. Which is characterized by great temporal accuracy compared to other satellites (time period of 16 days), and its spatial resolution is 250 m. The processing level is the third level [6].

Data were extracted and processed using a JavaScript code editor in the GEE (Google Earth Engine) platform (https://earthengine.google.com/),which provides big data processing capabilities for even very large study areas [2]. As showing in Figure 2.

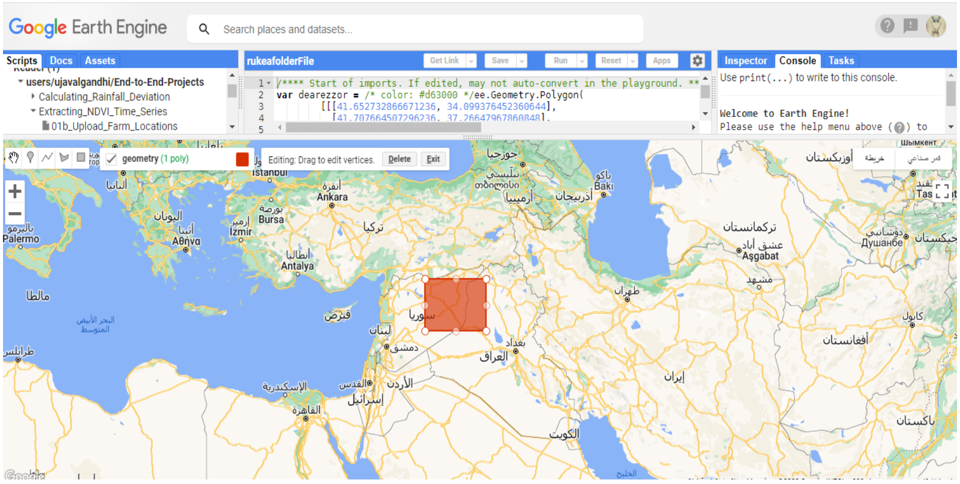

Figure 2. The GEE (Google Earth Engine) platform.

3.3.2. Rainfall Data

Annual rainfall data for the period 2012-2022, obtained from the Agricultural Rainfall Enhancement Project, were used to determine the average rainfall for the study area for five rain stations: Deir ez-Zor, Al-Tebny, Souar. Meaden, Abu Kamal. Figure 3.

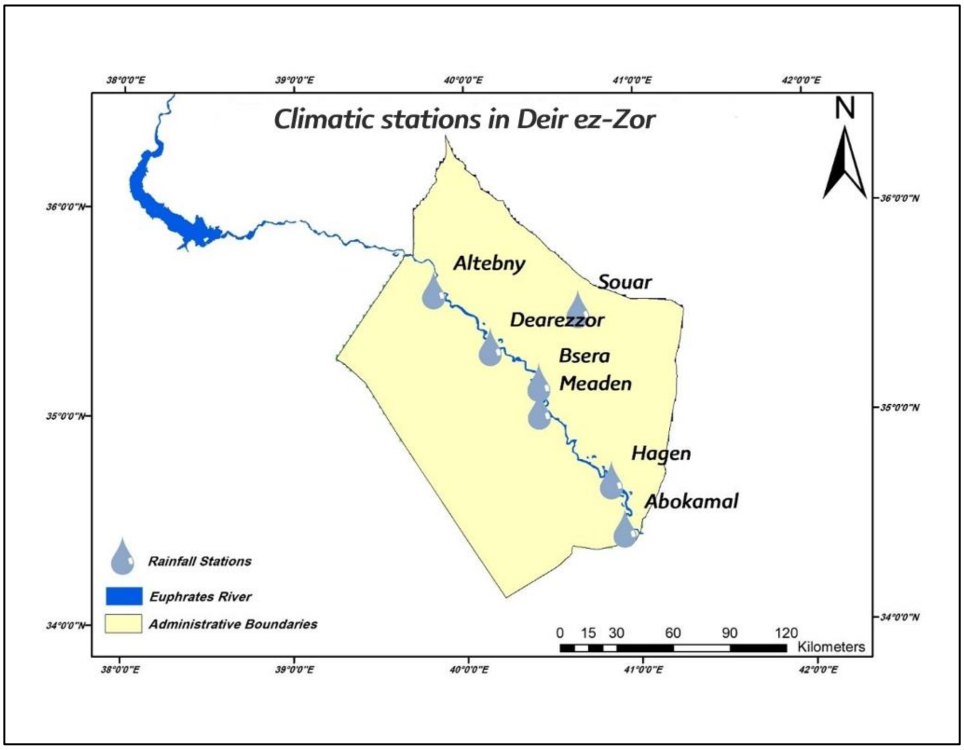

Figure 3. Climatic stations in Deir ez-Zor.

4. Methodology

4.1. Rainfall Maps

Rainfall maps for the study area were prepared using the annual Rainfall rates for the five climate stations within the ArcGIS 10.8.2 environment using the Kriging tool from Spatial Analyst (Figure 4). The Krigink model is an important geostatistical technique, which is a best unbiased linear interpolation procedure, and an approximation technique that gives the best prediction of the unknown values of the random function. This prediction is a weighted combination of the measured values [7].

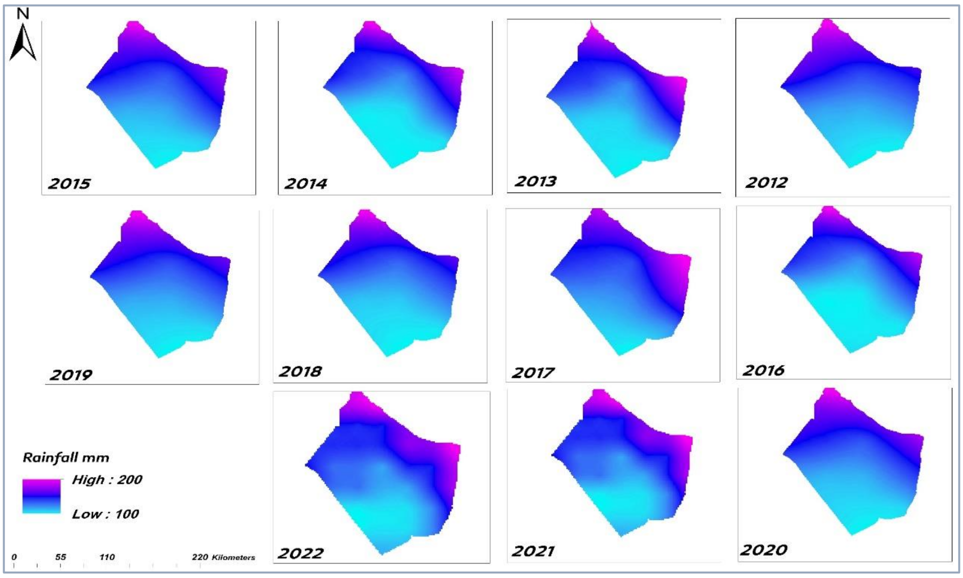

Figure 4. Rainfall maps for the study area for the time series 2012-2022.

4.2. Normalized Difference Vegetation (NDVI) Maps

It is considered the most widespread indicator, it is the ratio between the reflectance difference in the red and near infrared (NIR) spectral bands relative to their sum [8], it is calculated from the following equation:

$$NDVI = (NIR-R)/(NIR+R) \tag{1}$$

The area of Deir ez-Zor Governorate was clipped from the satellite images according to the administrative boundaries approved by the Ministry of Local Administration, and the satellite images representing the NDVI index were classified into rows using ArcGIS 10.8.2. as Table one shows:

Table 1. NDVI index classes.

Classification	NDVI
	−0.8
water	−0.5
	0
Barren lands	0.1
Pastures, grass, shrubs	0.2
	0.3
Medium plant cover and field crops	0.4
	0.5
	0.6
forests	0.76
	0.82

Figure 5. shows NDVI Maps in April of each year for the study area during the time chain (2012-2022).

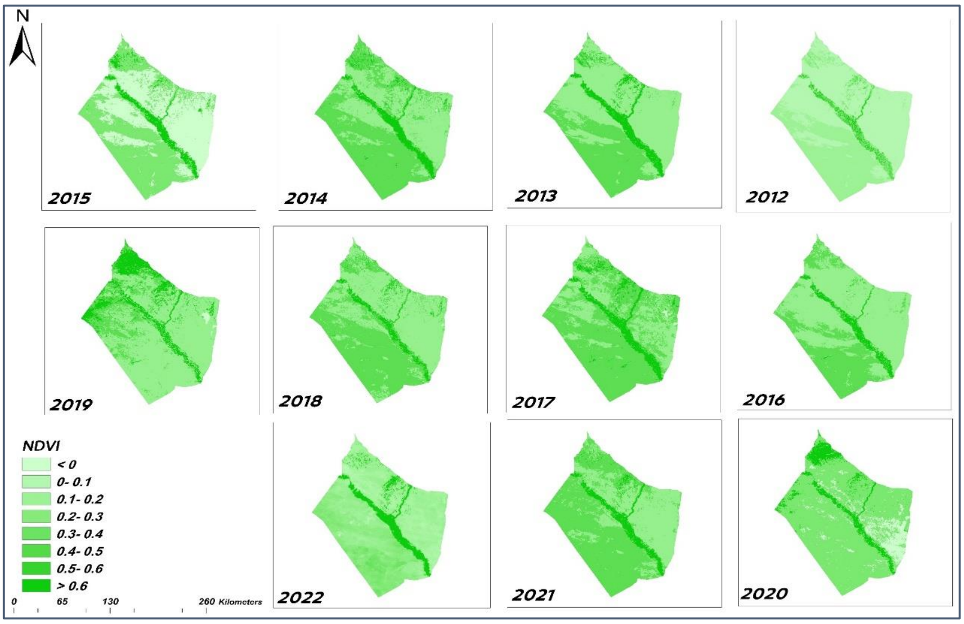

Figure 5. NDVI maps in April of each year for the study area during the time series (2012-2022).

5. Results and Discussion

5.1. Correlation of Rainfall with NDVI Index

The results showed that the lowest value of the NDVI vegetation index was in (2016) with an average of 0.098, which represents the driest years during the studied series, corresponds the lowest rainfall rate in the studied series (131 mm), while the highest value was in 2019 with an average of 2.4. This corresponds to the highest mean rainfall of 206.67 mm, thus represents the least dry years during the same series. There was also a strong correlation (R = 0.7) between the general mean rainfall amount for the studied time series and the general mean values of the NDVI vegetation index. We also observe relatively average values of the NDVI index during the rest of the years, accompanied by rainfall values as well, Figure 6 shows this:

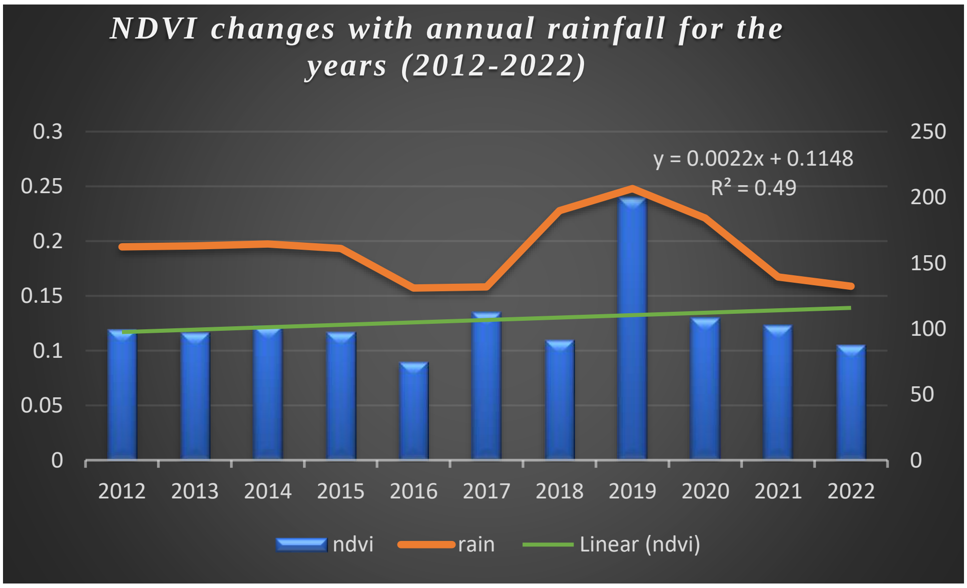

Figure 6. NDVI changes with annual rainfall for the years (2012-2022).

The NDVI vegetation index maps, which were classified into rows from (-0.2 to 0.8) using the (ArcGIS 10.8.2) program, also showed: The barren lands with simple grass coverage (0-0.1) occupied an area estimated at 90% of the total area of the studied region, with the exception of the year 2019, where pastures and rain-fed crops (0.3-0.4) occupied 85.45% of the total area of the studied region. (Figure 7).

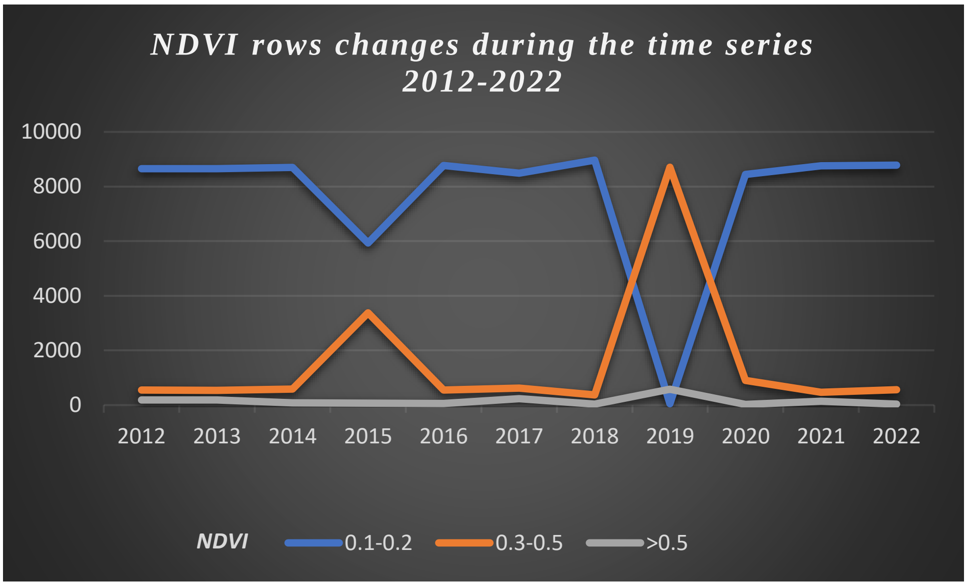

Figure 7. NDVI rows changes during the time series 2012-2022.

6. Conclusion:

The study concluded several results, the most important of which are:

-The study showed that changes in the vegetation index (NDVI) are related to changes in rainfall, which indicates the possibility of using it to estimate, and study drought as a simple method derived from satellite data in isolation from ground data.

-The NDVI maps, which were classified as (-0.2 - 0.8), using ArcGIS 10.8.2, showed that arid land with a simple herbal coverage (0-0.1) occupied 90% of the total study area with the exception of 2019, where pastures and rain-fed crops (0.3-0.4) occupied 85.45% of the total study area.

-The effectiveness of using MODIS satellite images to derive drought indicators for any region in the world. Using these indicators, the development and severity of drought in a country or region where ground observations are absent or limited can be monitored and estimated (such as Syria and the Arab region).

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments:

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Al Bitar, A., Najem, S., Jarlan, L., Zribi, M., & Faour, G. Precipitation and soil moisture datasets show severe droughts in the MENA region, 2021.
2. Amani, M., Ghorbanian, A., Ahmadi, S. A., Kakooei, M., Moghimi, A., Mirmazloumi, S. M., ... & Brisco, B. Google earth engine cloud computing platform for remote sensing big data applications: A comprehensive review. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2020, 13: 5326-5350.

3. Climate Atlas of Syria. Ministry of Defence.Meteorological Department. Climate Division Service of military geography, 1977,150.
4. Daher, J. Water scarcity, mismanagement and pollution in Syria. European University Institute, 2022.
5. Lyall, N., Shaar, K. Out of the frying pan into the fire: The Impacts of the Contemporary Drought in Syria and Its Implications for the Conflict. Operations and Policy Center (OPC), 2022.
6. Marshall, M., Okuto, E., Kang, Y., Opiyo, E., & Ahmed, M. Global assessment of vegetation index and phenology lab (VIP) and global inventory modeling and mapping studies (GIMMS) version 3 products. *Biogeosciences*, 2016, 13.3: 625-639.
7. Poshtmasari, H. K., Sarvestani, Z. T., Kamkar, B., Shataei, S., & Sadeghi, S. Comparison of interpolation methods for estimating pH and EC in agricultural fields of Golestan province (north of Iran). International Journal of Agriculture and Crop Sciences (IJACS),2012, 4(4), 157-167.
8. Rouse Jr, J. W., Haas, R. H., Deering, D. W., Schell, J. A., & Harlan, J. C. Monitoring the vernal advancement and retrogradation (green wave effect) of natural vegetation. No. E75-10354. 1974.
9. Wehrey, F., Dargin, J., Mehdi, Z., Muasher, M., Yahya, M., Kayssi, I., ... & Yabi, G. Climate Change and Vulnerability in the Middle East,2023.
10. Wei, W., Zhang, J., Zhou, L., Xie, B., Zhou, J., & Li, C. Comparative evaluation of drought indices for monitoring drought based on remote sensing data. Environmental Science and Pollution Research, 28, 20408-20425, 2021.