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NDVI and E. de Martonne Indices in an Environmentally Stressed Area (Thriasio Plain – Greece)

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Abstract

In this paper we examine the possible differentiations of the E. de Martonne climatic aridity index in conjunction to Normalized Difference Vegetation Index – NDVI index. For this purpose meteorological data cover the period from 1958 to 2011 was used. Also for three Landsat satellite images NDVI index was performed. The results for the climatic index show a trend towards characterizing the climate as warmer and drier. The latter conclusion is consistent with intense land use change in the area of interest, and is due to a shift in the management of surface waters used for crops irrigation in the region.

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Keywords: Environmental Education; water; general and technical secondary education

1. Introduction

In Greece the pollution of the environment and the diminution of forests and natural ecosystems date back to the beginnings of the industrial revolution, although it mainly happened during the last 40 years. The industrial development in each country was followed by nature's destruction to a large or small extent, depending on the type of industries, the size of the cities, the local climate, etc. Among other consequences, plant mortality, pollution of surface and ground waters, as well as dramatic depletion of flora and fauna species and populations were recorded in industrially developed countries of the West and East Europe.

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The present study focuses on the evolution of the E. de Martonne climatic aridity index in conjunction to Normalized Difference Vegetation Index – NDVI index [1], [2], [3]. For this purpose meteorological data used cover the period from 1958 to 2011. Also for three Landsat satellite images NDVI index was performed. Given the close relationship between cultivation and precipitation, vegetation conditions can reflect the impact of droughts. Satellite-based vegetation indices have been widely used for vegetation condition monitoring.

2. Materials and Methods

The data used refers to Elefsis station (LGEL) for time period 1958–2011 and were provided from Hellenic National Meteorological Service. Data included monthly average values of air temperature, relative humidity, and precipitation.

The de Martonne index calculates the dryness of a region and highlights the current circumstances basin. It is estimated by the formula:

$$\mathrm{I} = \frac{P}{T+10} \tag{1}$$

where: P–annual rainfall, T–Average Annual Rate of air temperature [oC], [4].

The three Landsat multi-channel satellite images refers to years 1977, 1991 and 2000, have a resolution of 240m and were obtained from the following database: http://edclxs2.cr.usgs.gov/ [5] and http://zulu.ssc.nasa.gov/mrsid/mrsid.pl [6]. On these images, we “filtered” the outline of authorized uses of land, so that it is easier for the reader to understand the differences from the current situation. Outlines were made in UTM–WGS84 coordinate system.

3. Results and Discussion

The de Martonne climate index shows a normal volatility with the absence of extreme fluctuations. But what seems clear is that the average index is calculated for lower values. During two years is calculated above 10 while precipitation is less than 200 mm and 150 mm, suggesting significant dryness of the area, to such an extent as to reach the stage of desertification. It is worth noting that in any case, the de Martonne index is above 6. Furthermore a very impressive result is that the climate is characterized as "Mediterranean" only during two years, while in one case the climate is classified as "semihumid".

Mann-Kendall test was applied, whereas the crossing of the stepwise curves u(t) and u’(t) suggests the turn point years were 2007 and 1989. The year 2007 was warmer and drier than 1989. During the summer of 2007 were observed four heat waves events [7], [8], [9]. Moreover during the same year were recorded low values of total rainfall and the average monthly value of the ambient temperature exceeded the average of the period under review.

In the last years, Thriasio Plain has been going under a transformation. This transformation is better understanding if we examine NDVI index from Landsat images. Areas covered by olive trees and rural areas are systematically deforested, creating more space for concrete developments. Warehouses of thousands of square meters, transport companies, manufacturing units and other land-disturbing activities are shifting to the five municipalities of the area, causing new suffocation to the area, not only due to the additional environmental degradation of the area, but also due to the consequent deterioration of traffic problems (Figures 2).

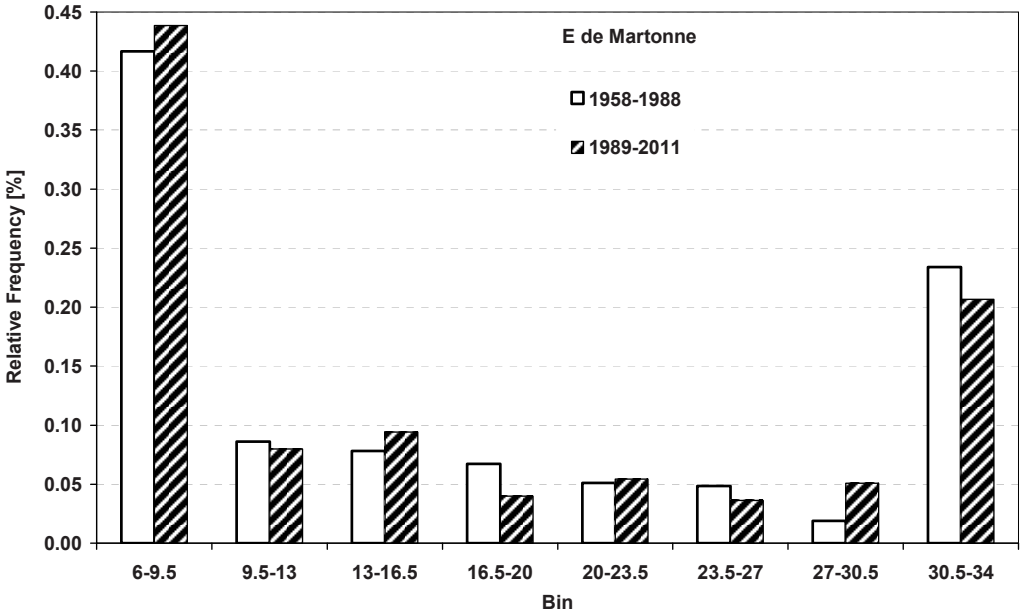

Fig. 1. Percent distribution of arid I < 10 & P < 200mm; dry 10 < I < 20 & 200mm < P < 400mm; semi-dry 20 < I < 25 & 400mm < P< 500mm and sub-humid I > 25 & 500mm < P < 600mm years according to de Martonne classification for two time periods in Elefsis (LGEL).

One of the outcomes of the «Action Plan for spatial and sectional development in Thriasio Plain and Western Attica» [10] was, among others, the shrinking of agriculture and farming and the degradation and gradual disappearance of the olive grove. Until recently the most important problems were mainly noticed in the coastline area, and the mainland area of Thriasio consisting of olive trees and crops counterbalanced the deterioration of the area, bringing considerable balance to the situations. This counterbalancing effect not only ceases to exist rapidly, but also it is being replaced by concrete.

In Thriasio Plain the new complex being constructed contains land-disturbing activities, warehouses and transport services. Similarly to some decades ago, when the olive grove of Athens disappeared, today we witness the disappearance of the olive grove of Thriasio and indeed, with the tolerance of the legislative frame, as new urban plan allow this situation. The concentration of land disturbing activities in Thriasio does not only bring about environmental degradation, but it also poses a long-term risk for the mountain of Parnitha. Already on the west part of the mountain as well as alongside the National Motorway Elefsis–Thiva, new off–plan towns emerge. These areas surrounding Aspropyrgos and are near northern Magoula and northern Mandra, in which scattered off-plan residences have preexisted for decades, and today these scattered have begun to form rapidly into areas known as “the villas of the poor”.

A catalyzing role for this development had Attiki Odos, and also the new commercial station of the Hellenic Railways Organization and the new port of Elefsis. The sector currently thriving is the warehousing facilities and transit centers. Warehouses are rapidly replacing rural land. What is worse is the fact that although the actual surface in use is e.g. 20%, the remaining 80% is “cemented” in order to serve as a parking space for the vehicles, loading and unloading of goods etc. As a result, the area cannot “breathe”, temperature is rising and rain water cannot be absorbed. Although most industrial areas are zoned, no urban plan was applied, which means that no industrial parks were built that included greenery and other facilities [8, 9, 11, 12, 13, 14].

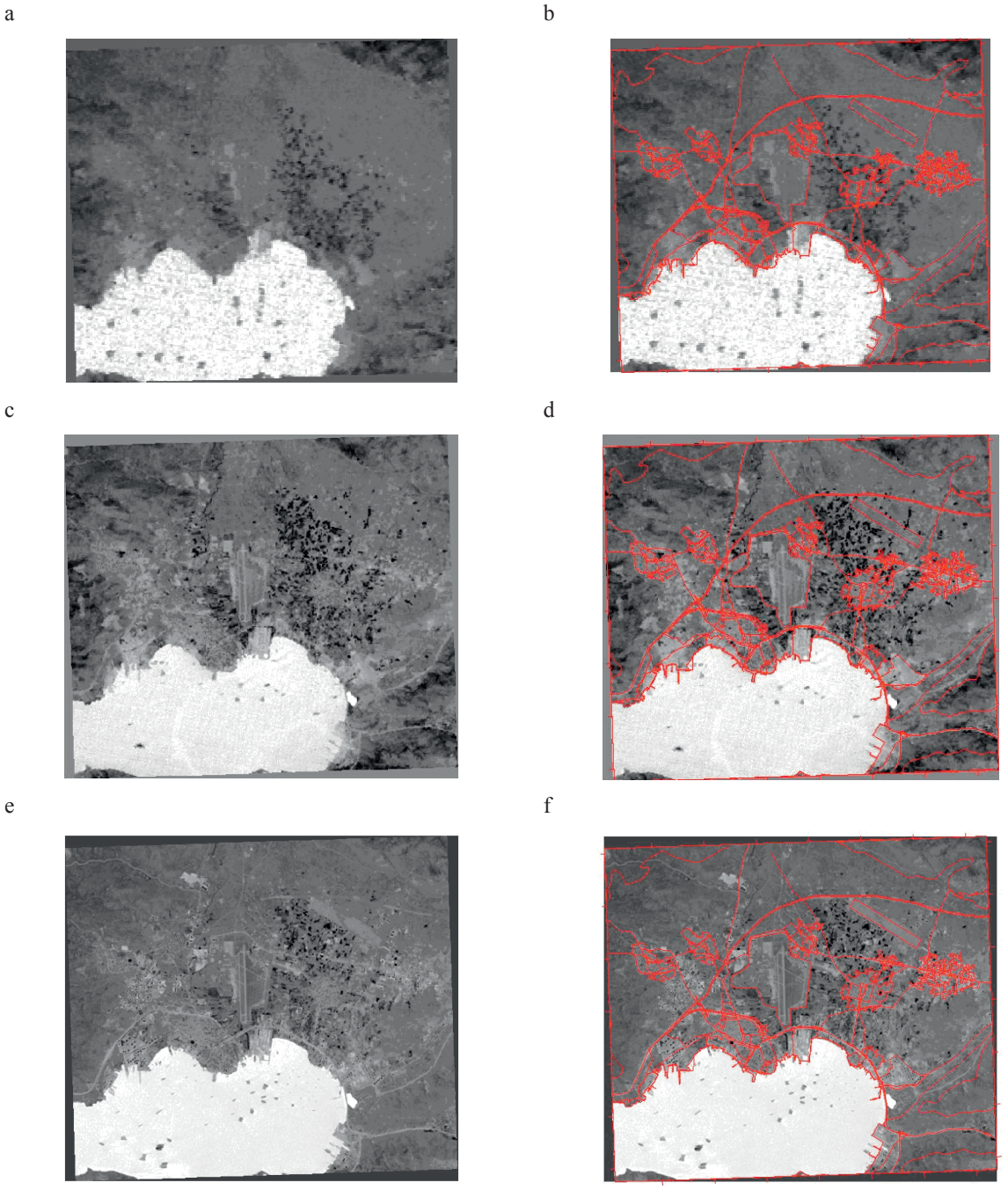

Fig. 1. a) NDVI index 1977. Crops and the olive plantation of Thriassion are displayed with black and dark grey, surrounding Aspropyrgos (in the center of the image) and E-NE areas of Elefsis. c) NDVI index 1991. The degradation of crops and expansion of activities has started (displayed with light grey). e) NDVI index, 2000. The degradation of crops, expansion of activities and erection of large infrastructure developments is manifest. b), d), f) The corresponding overlays outlines (1977 – 1991 – 2000) for the authorized land uses as of year 2000 inventory

4. Conclusions

An overview of the findings leads us to the following conclusions:

The description of the climate achieved, by applying the de Martonne index. According to this index the climate of Thriasio Plain began warmer and drier and characterized as a semi–arid.

The latter conclusion is consistent with intense land use change in the area of interest, and is due to a shift in the management of surface waters used for industrial and rural purposes and crops irrigation in the region [15].

NDVI index derived from Landsat satellite images, confirm the conclusion above.

This result could be a strong indication of the feature climate of the area.

From all the above results, it is reasonable to wonder about whether desertification is becoming a major problem of the area or not.

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