University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Drought Network News (1994-2001) Drought -- National Drought Mitigation Center

October 2000

Potential Use of NOAA/AVHRR Satellite Data for Monitoring Environmental Change in Turkey

Ali Umran Komuscu
Turkish State Meteorological Service

Follow this and additional works at: https://digitalcommons.unl.edu/droughtnetnews

Part of the Climate Commons

Komuscu, Ali Umran, "Potential Use of NOAA/AVHRR Satellite Data for Monitoring Environmental Change in Turkey" (2000). *Drought Network News (1994-2001)*. 23.
https://digitalcommons.unl.edu/droughtnetnews/23

This Article is brought to you for free and open access by the Drought -- National Drought Mitigation Center at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Drought Network News (1994-2001) by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

Potential Use of NOAA/AVHRR Satellite Data for Monitoring Environmental Change in Turkey

Introduction

In Turkey, desertification has been taking place in areas of low rainfall and minimal vegetative cover. In particular, the central, eastern, and southeastern parts of the country are vulnerable to desertification because of erosion, deforestation, and degradation of vegetative cover. Rivers of those regions are characterized by very high sediment yields. Nearly 60% of the country's soils are subjected to severe erosion and approximately 450 million tons of sediment are carried to rivers each year. Meanwhile, wind erosion has been a very effective desertification process in central and southeastern parts of the country, where annual rainfall varies around 400–500 mm/year. Most central and southeastern parts of Turkey are considered semiarid, and some parts of the Central Anatolia region around Tuz Lake exhibit arid conditions, with 300 mm/year rainfall.

This study presents a potential use of remote sensing for monitoring desertification with AVHRR-derived NDVI (Normalized Difference Vegetation Index) data. NOAA series operational meteorological satellites provide data that can be used for various earth observation applications, such as vegetation indexes, sea surface temperatures, hydrologic applications, and natural disasters. The Advanced Very High Resolution Radiometer (AVHHR) is a multichannel scanning radiometer carried by the NOAA Polar Orbiter satellite series. It is a 5-channel radiometer, using a spinning mirror to scan across 111 degrees for a ground swath of 2,700 km, with an IFOV at a nadir of 1.1 km. Because of the temporal characteristics of AVHHR, it is possible to obtain valuable information for vegetation monitoring studies and other environment-linked applications (Gutman, 1991).

The use of satellite data for nonmeteorological applications in Turkey has been gaining momentum in recent years with the establishment of new HRPT stations. NOAA/AVHHR raw data used in this study were obtained from an HRPT receiving station located at the Turkish Scientific Research and Technical Council-Information Technologies and Electronics Research Institute (TUBITAK-Bilten), Middle East Technical University (METU), Ankara. The NOAA/HRPT receiving station in this institute was established in 1997 through the TU-REMOSEN Project under the NATO Science Stability Program. The station has received data from NOAA 11, 12, and 14 regularly since 1997

ORBIT

NOAA 12–14 (since 1994 at Erdemli and 1997 at Tubitak-Bilten, Ankara)
NOAA 15 (since it was launched)

AVHRR Sensor

Band	1	2	3	4	5
	0.58–0.68	0.725–1.0	3.55–3.93	10.30–11.30	11.50–12.50

FORMAT

Rows	Columns	Radiometric Res.	Data Volume	Spatial Res.	Temporal Res.
1,700–1,900	2,048	10-bit	35–40 Mb	1.1 x 1.1 km.	12 hrs.

Table 1. Technical summary of satellite data used in the study.

and from NOAA 15 since it was launched. The data set used in this study is composed of 5-channel, 10-bit, raw AVHRR data, 2,048 pixels wide, at 1.1 km resolution (at nadir). It consists of only the afternoon (ascending) passes (Table 1). The data included in the study covers the period from July 1997 to May 1999.

Turkey has diverse vegetation cover, and that provides opportunities for using NOAA/AVHHR data for monitoring vegetation conditions across the country. In this study, the main emphasis is given to three regions that differ in vegetation and land-use characteristics. The selected regions are defined by grids that vary slightly in areal coverage. Region I represents the part of Central Anatolia that has the lowest annual precipitation in the country and lacks a major vegetative cover. The area underwent serious land degradation in the past and is still at great risk for drought and desertification. Region II covers part of the Aegean region where irrigated agriculture is practiced, and it is also relatively rich in forests. The third region is located in the Marmara region, which is the heavily urbanized and industrialized part of Turkey. This area is also covered by dense forests.

The Normalized Difference Vegetation Index

Many techniques have been developed to quantitatively and qualitatively study the status of the vegetation from satellite images (Kidwell, 1994). Based on the reflectance difference that green vegetation displays between the visible region and the near infrared region of the electromagnetic spectrum, in channels 1 and 2 of the AVHRR images of the NOAA satellites, the NDVI has been obtained (Goward et al., 1991). The NDVI formula takes the following form in the context of AVHRR derived data:

$$NDVI = \frac{r_2 - r_1}{r_2 + r_2}$$

where r_1 and r_2 are the reflectance values measured in AVHRR channel 1 (red) and channel 2 (near infrared), respectively. AVHRR channel 1 (0.58–0.68 µm) senses an area of the spectrum that shows an inversely proportional relationship to the amount of green vegetation present. On the other hand, AVHRR channel 2 (0.725–1.0 µm) senses a region of the spectrum with reflectance directly proportional to the density of photosynthetically active vegetation. The denser and more vigorous the vegetation is, the higher the reflectance of near-IR radiation. The range of values obtained by the NDVI is between -1 and +1. Increasing positive NDVI values are usually shown in increasing shades of green on images, indicating increasing amounts of green vegetation.

Data Processing

Cloud-free AVHRR observations of the land surface are necessary for monitoring vegetation conditions with NDVI. Images that provided clear observation of the selected regions at reasonable nadir viewing angles are included in the analysis. However, it was impossible to find completely cloud-free images for the selected regions at desired time intervals.

AVHRR data is processed to produce NDVI using the standard formula given in the previous section. The procedure for producing the final NDVI involves several steps (Figure 1). In this study, Map-X Ocean software was used to process the raw images. The process to elaborate a vegetation index (NDVI) begins with the acquisition of a NOAA satellite image. We then choose a subset of the image to create the NDVI. In the first step, a quick look at the raw data is obtained. Then the data is georeferenced to assign map coordinates to the image. After geo-encoding and calibrating each band and correcting for solar zenith angle and satellite zenith angle, AVHRR visible bands 1 and 2 are used to produce an NDVI image using the standard formula given earlier. After various coloring and enhancement techniques, the product takes its final form. The image products are 10-bit data files, and viewable 8-bit images are generated after the process.

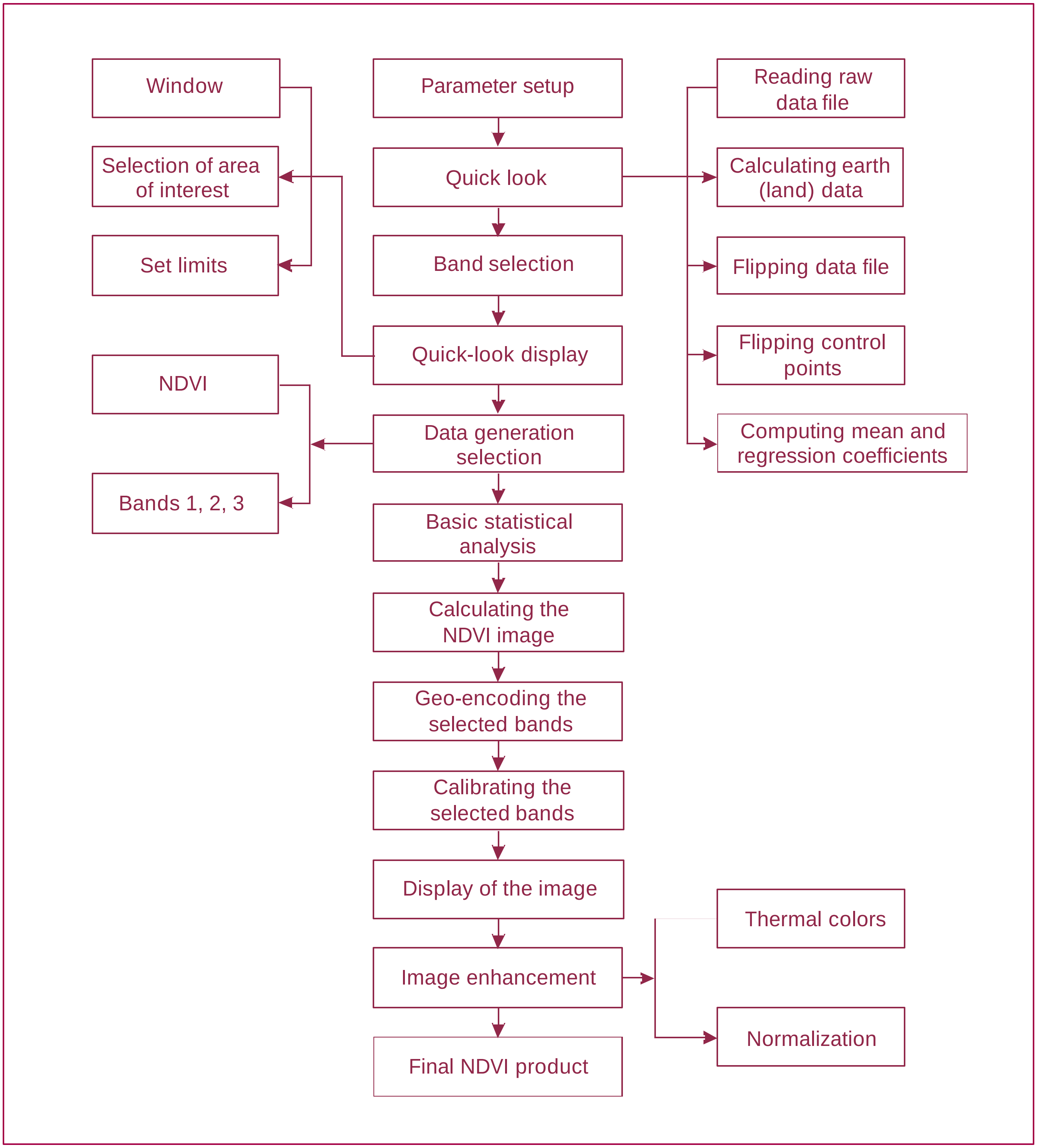

Figure 1. NDVI generation scheme by Map-X Ocean program.

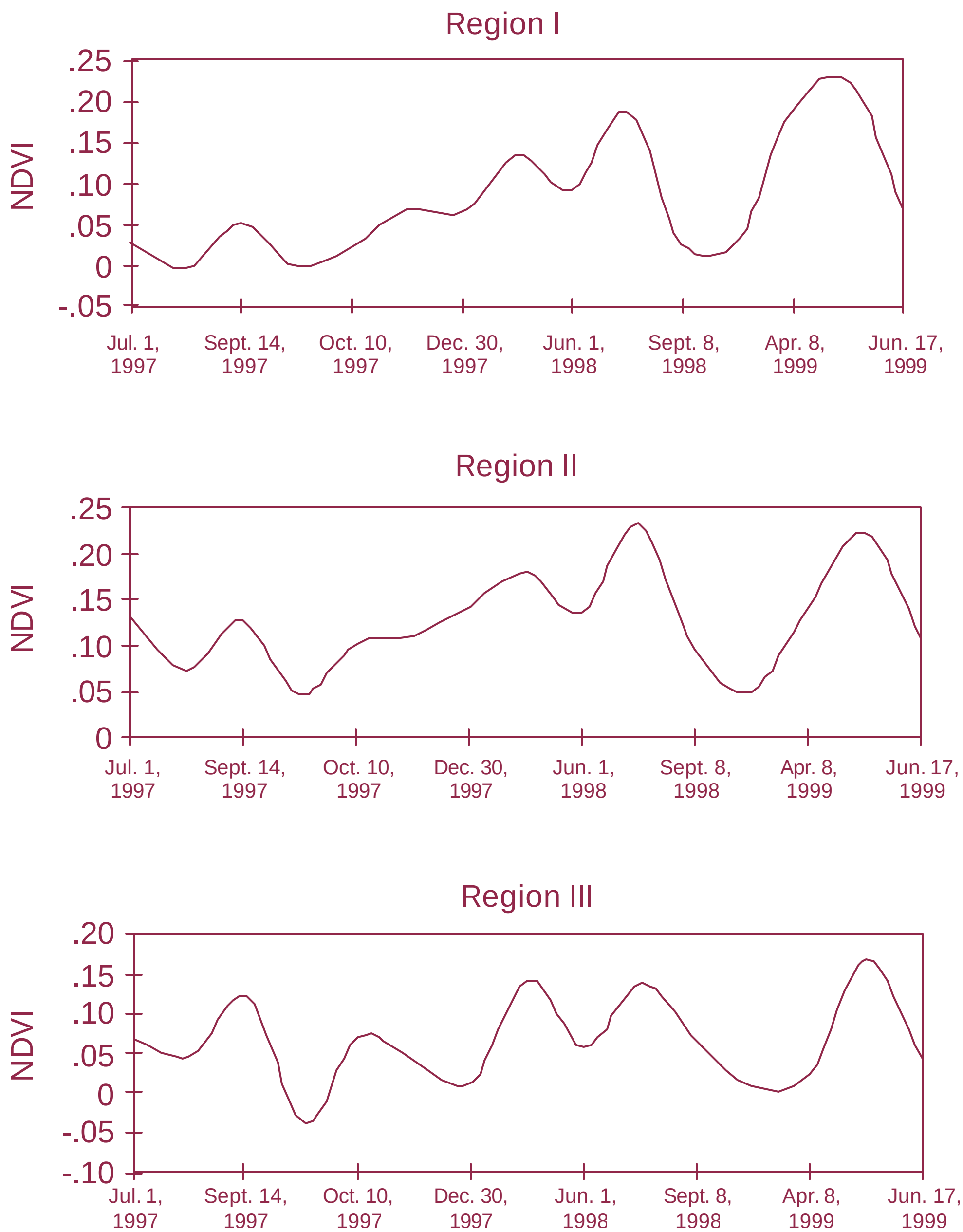

Figure 2. Temporal variations in NDVI for the selected regions.

NDVI Analysis and Results

In this study, mean NDVI and certain threshold values were evaluated with respect to their temporal changes for the selected areas, which represented different vegetation and land-use characteristics. Figure 2 illustrates time variations in NDVI for the selected regions. Interestingly, Regions I and II exhibit similar patterns, except that negative values are dominant in certain periods in Region I. That is typical, considering the lack of vegetation in the region. The values usually peak in summer months, when green biomass is greatest in all the regions. Peaks in biomass activity in the summer periods of both 1998 and 1999 are common in all three regions. Region III exhibits a more variable temporal pattern of NDVI data and is characterized by negative values in certain periods, which is likely the result of inclusion of a large water surface in the analysis. It should be kept in mind that Region III has a very diverse surface cover, including industrial areas, dense settlements, and forest cover in the north. It is our belief that cloudiness in the images also affected variation of the NDVI values to a certain extent.

The study proves that the NDVI is a useful tool for monitoring vegetative conditions and other land-use characteristics in desertification-prone areas. By examining the NDVI values over a period of time, it would be possible to monitor long-term trends in desertification processes in Turkey and include such information in drought and desertification mitigation programs. Further investigation of NDVI data will be done as the data becomes available.

Acknowledgments

Data used in this study were provided by the Turkish Scientific Research and Technical Council–Information Technologies and Electronics Research Institute (TUBITAK-Bilten), Middle East Technical University (METU). The authors wish to thank the staff of the TUBITAK-Bilten for providing the data and their assistance during the course of this study.

Dr. Ali Umran Komuscu
Research Division
Turkish State Meteorological Service
Kalaba, Ankara, Turkey
fax: (90) 312–359 34 30
e-mail: aukomuscu@meteor.gov.tr

References

Goward, S. N.; B. Markhan; D. G. Dye; W. Dulaney; and J. Yang. 1991. Normalized Difference Vegetation Index measurements from the Advanced Very High Resolution Radiometer. *Remote Sensing of Environment* 35:257–277.

Gutman, G. G. 1991. Vegetation indices from AVHRR: An update and future prospects. *Remote Sensing of the Environment* 35:121–136.

Kidwell, K. B. 1994. *Global Vegetation Index User's Guide*. U.S. Department of Commerce, Washington, D.C.

Pereira, J. M. C. 1998. A comparative evaluation of NOAA/AVHRR vegetation indices for fire scar detection and mapping in the Mediterranean-type region. *IEEE Transactions on Geoscience and Remote Sensing* (in press).

Additional Sources:

Report on NOAA–HRPT Systems and Basic Use of AVHHR Data in Meteorology, prepared by the Research Department of the Turkish State Meteorological Service, Ankara, 1999.