Determination the Normalized Difference Vegetation Index (NDVI) for the NH-38-2 Al-Najaf Plateau, Iraq with the Assistance of the Remote Sensing Technology

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Abstract. The satellites and the data that is provided by are an effective way to distinguish the characteristics of agricultural crops, crops density, and the changes that affect the vegetation cover. The Normalized Difference Vegetation Index (NDVI) has been widely used in conducting a quantitative assessment of plants that cover the surface of the earth, as it revealed many problems facing the agricultural environment, especially those located in arid or semi-arid areas. This study dealt with analyzing the vegetation cover of the plateau NH-38-2 located in Al-Najaf, Iraq by finding the NDVI using remote sensing technology and Geological Information System (GIS), in addition to finding its value for the study area. The study showed that the vegetation cover is largely non-existent and ranges between (0-1) as the region suffers from desertification, which requires the relevant authorities to rectify the matter by developing projects that will increase the vegetation cover as it helps to improve the environment. In addition, the study showed that there is an area that does not exceed 110 km$^2$ that contains vegetation, which is a very small area compared to the total area under study, which is 15225 km$^2$.

Keywords: Normalized Difference Vegetation Index (NDVI), Remote Sensing Technology, GIS, NH-38-2 Al-Najaf Plateau, Iraq

1. Introduction

The problem of the degradation of vegetation cover and the phenomenon of desertification are among the environmental problems that must be studied in the arid and semi-arid regions of the world, as the continued depletion of the natural vegetation cover leads to a deepening of the degradation of vegetation cover and the phenomenon of desertification [1]. The estuarine environment is a very sensitive environment to the nature of natural, human and economic variables. These variables are characterized by coastal geomorphic units that are affected by wave processes on one side and on the other side by river operations, thus forming many landforms that are severely affected by the impact of those geomorphic processes affecting them [2]. The risk increases with lower levels of rainfall and an increase in the areas affected by salts in addition to the emergence of sand dunes. In addition, the population growth rate increases the demand for environmental resources to meet the development needs of all sectors, including industrial, agricultural, energy and transportation. Natural factors also play a major role affecting the agricultural population areas through the changing natural factors of the...
region, which are the geology, surface, slope, climate, hydrology and the vital environment of the region. As for the human and economic factors, the outfall environment is characterized by a dense population concentration in it and the diversity of the nature of land use and economic activity in it, which negatively affects the safety and durability of this environment, which requires the development of sustainable solutions to monitor environmental degradation in these environments [3].

The increasing consumption of water, energy and other resources has led to an increase in the volume of waste and the deterioration of natural resources. Being aware of the size of the problem and knowing its limits requires monitoring large areas, either by field methods that require a lot of effort and material capabilities, or by using remote sensing technology. Remote sensing technology is one of the modern means of studying natural resources with all that it provides in terms of reducing efforts and material capabilities and monitoring large areas [4]. Remote sensing technology represents the best method for monitoring vegetation density, especially in areas that are inaccessible, as it has been widely used as an effective analytical method in improving multi-spectral visuals. Among the capabilities provided by remote sensing technology is to estimate the abundance of green plants, the photosynthetic activity of the solar system, the green density available on the surface of the earth, plant stress and plant health, as well as the possibility of obtaining even an approximate amount of agricultural crops production. The vegetative indices depend largely on the spectral reflectance of two or more spectral bands, and they are often the red and near infrared bands, where the difference between them indicates the amount of green biomass [5].

Yang et al., 2008 [6] studied plant indicators by observing the extent to which they are affected by solar illumination resulting from topographical changes, after excluding shadows and slopes, while observing the degree of difference in the intensity of the sun angle in the areas exposed to solar radiation. Chopping et al., 2008 [7] developed 150 botanical indicators with the aim of improving the value of plant indicators and making them reliable in scientific studies by overcoming everything that reduces the effectiveness of plant indicators. As it takes into account all the external and internal climatic conditions that may affect the effectiveness of the plant indicator, and thus the characteristics of the studied area can be determined. Ramachandra, 2007 [8] studied the extent of the influence of the type of vegetation soil, as there are some places where the vegetation cover is dense and others are not dense as this does not depend on the type of soil, which indicates that the vegetation coverage index is affected only by the light reflected from the surface of the plant or the surface of the earth, which is Which determines its value. Bannari and Asalhi, 2004 [9] studied the efficiency of plant indicators by checking their susceptibility to external influences as well as their efficiency in monitoring the characteristics of agricultural crops in places with different climates and undulating terrain. The objective of that study was to develop an ideal plant index or parameter that has the ability to overcome the different solar spectra and is not affected by the atmosphere and environmental influences when estimating the vegetation index.

In the current research, the remote sensing technique is chosen to provide the green and desert topographic map as well as to identify the locations of the water areas of the topographic plate by determining the indicator of vegetation coverage of the aforementioned plate in order to reveal the nature and extent of change in this important environment that must be preserved.

2. Description the Study Site

The area under study represents Al-Najaf plate in the series of quarter-million maps, bounded on the north by a circle of latitude 32° North, from the south, latitude 31° North, from the east (145 km), longitude 45° East, and from the west, longitude 43° 30' East (105 km) (Figure 1). The total area under study is 15225 km². The Al-Najaf plateau area represents part of the Western Sahara region, which includes in its nature a wide plateau that is tectonically stable, and is characterized by a regular slope from the southwest to the northeast. The northeastern part of the map lies within the alluvial plain and returns to the unstable pavement. The modern deposits cover about a quarter of the area of the map represented by the Pleistocene and Holocene deposits. As for the pre-Quaternary deposits, their ages range between the Paleocene and the Pliocene, represented by the Umm Al-Radhama, Dammam,
Laurel, Euphrates, Al-Nafail, Al-Fathah, Anjana, Zahra and Dibdibba formations. The climate of the region is subject to the climatic conditions of the Western and Southern Sahara in terms of temperature, precipitation, and humidity [10].

The Formation of Dammam is the deepest aquifer in Al-Najaf plateau, and that the groundwater moves from the main recharge areas in the west and southwest towards the Euphrates River in the east, where the drainage areas fall within the range of the Al-Ayoun and the sedimentary plain. And that the water quality in the Dammam Formation is mostly sulfate except for some wells within the Al-Ayoun area, where the water quality is chlorinated, while the water quality in the sedimentary plain areas is chlorinated and the salinity rises towards the northeast of the region. The direction of groundwater movement within modern sediments is from northwest to southeast, partly from west to east, and vice versa and from north to south [11].

The region’s climate is subject to the same conditions of the Western Sahara climate in terms of temperature, rainfall, and humidity, as it is characterized by cold winters with little rain and dry summers. According to the Atlas of Iraq (1971-2000), the region is characterized by an annual average of temperatures (38.5°C), an annual rate of relative humidity (41%), an annual rate of evaporation (3450 mm), an annual rate of rain (100 mm), a drought coefficient (34) and an annual average of winds (3.4 m/s) [12].

3. Description of the Normalized Difference Vegetation Index (NDVI)
Remote sensing is a highly efficient and economical way to collect information about land cover. Rather, remote sensing has become more than that, as information about vegetation cover and its health can be obtained and the stages of its growth can be monitored through multiple-scale visualizations [13]. The methods have varied in many studies and many analytical methods have been reached to distinguish vegetation from other coverings by using remote sensing data and taking advantage of the spectral indication of the incident infrared rays reflected from the vegetation cover on the surface of the earth [4].

The distribution of vegetation cover on the surface of the earth depends on natural and anthropogenic factors. The natural factors are represented by the nature of the surface and the type of soil, which has a direct effect on the plant, as it is responsible for providing the plant with the nutrients necessary for its growth, and the spread of the plant in any environment is linked to temperature and
humidity. Where, for example, when an area becomes drought, the ecological balance is disturbed as a result of the destruction of the vegetation cover of that region. As for the human factors, they are represented by logging, overgrazing and uncontrolled grazing, and the exploitation of agricultural lands for the sake of urban expansion, which affects the food chain and the environmental balance. The process of continuously monitoring the density and distribution of vegetation cover through remote sensing techniques and geographic information systems is sufficient to protect and preserve the ecosystem from degradation [2].

The NDVI extraction/calculation method is a digital spectral optimization process used to detect and monitor vegetation. This coefficient in turn helps in describing the spatial distribution of the plant and its condition in the studied areas, as it appears in areas with dense vegetation cover in green and in areas with little vegetation cover with low reflectivity, i.e. less green gradation, as the reason for this is because this indicator depends on the relationship between rays Near-infrared and visible-infrared [1]. The following mathematical formula represents the relationship between the solar spectra and their reflection in which the difference generates the value of NDVI [14]:

\[
NDVI = \frac{(\text{Brand} 5 - \text{Brand} 4)}{(\text{Brand} 5 + \text{Brand} 4)}
\]  

Where Brand 3 and Brand 4 are the Red and Near Infrared (NIR) of the Red-Ray which refer to the visible and reflected rays from the cover of the plant crop, respectively. Note that the extracted values are between -1 to illustrate areas without vegetation cover and +1 to indicate areas where vegetation is present with high density.

4. Landsat Image of the Study Site

Landsat is a group of satellites launched by the NASA space agency since 1972 until now, and NASA gave it the serial designations of Landsat 1,2,3,4,5,6,7, and the last of them is now Landsat 8. Landsat 8 was launched on February 11, 2013, which is a group of satellites. The purpose of these satellites images is to explore parts of the earth in addition to civilian purposes. In the current research, the Thematic Mapper image of the study area will be downloaded from the Landsat 8 satellite, as shown in Figure 2. The Thematic Mapper image contains 8 bands, as the fourth and fifth bands will be used for the purpose of evaluating the density of vegetation cover.

Landsat 8 guarantees continued Landsat data collection and availability using two on-board sensors, the Operational Ground Imager (OHLI) and the Infrared Thermal Sensor (TIRS), respectively. These two tools collect image data within nine short wave bands and two thermal long ranges. The satellite was designed to do a 5.25-year mission, but it launched with enough fuel for another 10 years of operations. Landsat 8 aims to perform three main scientific tasks: 1) collecting and archiving multi-spectral image data that provides seasonal coverage of global land areas for a period of at least 5 years with a spatial resolution of 30 meters, 2) ensuring that Landsat 8 data is sufficiently compatible with mission data Landsat precedent in terms of acquisition engineering, spectral characteristics, calibration, coverage characteristics, the final results' quality, availability of data to allow studies of land cover and land use change over time, and 3) distributing of Landsat 8 data results to the general public without discrimination or cost [15].
5. Results and Discussions

This stage is considered one of the most important stages in this study as it required a lot of time and effort. Data of various kinds were collected from topographic maps and satellite visuals. The visualization of the study area was obtained from the Centre for Remote Sensing and Space Sciences by the Landsat 8 satellite with a spatial resolution of 30 meters. After that, the aerial image was improved, which is the process of showing the details of geographical phenomena on the visual, in order to make them easy to distinguish and identify them visually. Where it is difficult for the human eye to distinguish small geographical phenomena in which the spectral and radiometric differences are simple, as this problem can be overcome by applying the optimization process. This was done by applying the process of magnifying and amplifying the simple spectral and radiometric differences of the phenomena to be easily seen on the visual, such as the spectral improvements and the spatial improvements, which were applied in the research in preparation for the visual interpretation of the visual as shown in Figure 2. After that, the important area under study was truncated in order to extract the value of NDVI as well as clarify the places of chlorophyll on the study area.

The satellite visual information on studying the earth’s resources includes continuously renewed information about the earth’s surface, and this information and the various characteristics it contains are the most appropriate means for discovering the changes that occur on the earth’s surface. Vegetation cover represents the most important renewable resources on the surface of the earth as it is linked to the rest of the other natural resources. The importance of studying vegetation changes by remote sensing techniques.

The relationship between the red and near infrared ranges is always inverse in relation to plants, because the red rays are absorbed by (90%) by the plant due to its need for in the photosynthesis process. While the plant reflects a high percentage of near-infrared radiation because it does not need it, and the rate of reflected rays may reach about (90%). Where the more green and dense the plant increases, the spectral reflection value increases in the near infrared rays and the less in the infrared rays. Therefore, these two can be used to calculate the Normalized Difference Vegetation Index cover.

The study area is classified as a desert and arid region due to the lack of rain and the increase in
temperature rates, which makes it a dry area. Figure 3 shows the only dense green zone in the study area as this does not mean that there are no other green areas, but it does not rise to be influencing the value of NDVI. The result of the NDVI value ranged between (0-1), which clearly indicates that the dry desert areas represent the largest proportion of the studied area. While the green area was not more than 110 km², where these areas may be areas designated for growing wheat and rice crops or other seasonal crops.

![Figure 3. Distribution of chlorophyll on the study area.](image)

6. Conclusion
Monitoring the change in the ecosystem is one of the effective issues that concern the whole world at the present time, especially in dry or semi-arid areas, fragile and sensitive lands that do not have the right ecosystems and suffer from scarcity in rainfall and a sharp rise in temperatures. As these lands do not have the ability to restore their innate balance without human intervention, which mainly affects the food and economic security of the human being. The vegetation cover means the amount covered by the plant, whatever its kind, from the soil surface, where that vegetation coverage represents the result of the interaction of a set of dynamic natural factors and various human factors and activities. The efficiency of botanical indicators differs among themselves when assessing the characteristics of agricultural crops in any region to which they apply.

The current research deals with the plateau NH-38-2 located in Al-Najaf, Iraq, which has an estimated area of 15225 km². This area has been classified by the United Nations Environment Program as a dry or semi-arid region suffering from a severe shortage of rainfall and a large rise in temperatures that may sometimes reach about 50 °C, which generates a large rise in evaporation rates and in turn leads to dryness of the area. The aerial image of the study area was downloaded from the Landsat 8 satellite consisting of 11 brans, where after performing a geographic projection to it using the GIS program to convert it from geographical coordinates to metric coordinates (UTM), only the part that represents the study area was truncated (NH-38-2 Al-Najaf Plateau). After that, the mathematical equation for finding the Normalized Difference Vegetation Index (NDVI) was applied to extract its value and also to extract the locations of vegetation cover and its density in the study area. The study showed that the value of NDVI ranges from 0 to 1, indicating that most of the area under
study suffers from desertification and a severe lack of vegetation cover. The study also indicated that there is an area that does not exceed 110 km$^2$ that contains vegetation cover, which is a very small area if compared to the total area of the plateau under study, which is 15225 km$^2$. In summary, it is worth noting here that the relevant authorities in the city of Al-Najaf should follow up on establishing projects that would increase the vegetation cover in this region in order to reduce the impact of desertification and help improve the weather and housing environment in this region.

7. References

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