Plant Archives Volume 20 No. 2, 2020 pp. 5745-5750 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

MONITORING OF THE TEMPORAL CHANGES IN THE FORESTS OF NORTHERN IRAQ THROUGH THE DIRECTED CLASSIFICATION AND THE INDEX OF NATURAL VEGETATIVE DIFFERENCE

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Abstract

The mountainous region in Iraq is characterized by the presence of natural forests and rangelands, as it has a climate similar to the climate of the Mediterranean, unlike other parts of Iraq, which are characterized by a semi-desert climate, these forests are an extension of the Mediterranean forests, as they are not unique ecosystems, because they are under rugged topographic control with climate impacts, these forests have heterogeneous and unstable environments so that there is fragile environmental balance and prone to disturbances in general. The study was conducted in April 2014, in part of northern Iraq, to detect forest changes for the period from 1984 to 2013, as four Satellite images from Landsat TM were used by NASA. The data were processed and then categorized into eight categories of land use and land cover. The results showed a clear correlation between rainfall and forest change, more than the factors of human activity that were of limited impact due to the complex topographical nature (Wang, Qi and Cochrane, 2005).

Key words: North Iraq forest, supervised classification, land cover and land use, Landsat.

Introduction

The balance between conservation and sustainable use of forests is a global challenge, so monitoring forest dynamics to assess vegetation changes caused by humans are essential to achieving sustainable development.

The management of natural resources and the conservation of biological diversity are very important matters and understanding how these factors interact and affect the coexistence of species with their productivity is crucial to building future strategies. Population practices, such as deforestation, defore station, soil degradation, over-hunting wild animals and birds threaten the sustainability of ecosystems (Ministry of Environment, 2013), change may lead to the disappearance of important species and reduce other species due to the loss of their natural habitats, their food sources, hence other remaining species disappear, Preserving forests, improving them, with national, regional and international requirements in Iraq represents a challenge to prepare and adopt integrated, flexible and viable strategies, which is an urgent need for decision in this aspect.

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Forests in Iraq suffer from several problems that can be attributed to natural, human factors and incorrect policies such as wars and the economic blockade, the intensity of human activities that exert pressure causing fragmentation of the landscape, such as the opening of fields, the extraction of wood resources, the recurrence of fires, Which can be exacerbated in light of climate changes and therefore they are unable to work normally. Soil erosion is seen in many areas and the loss of its ability to regulate and protect waterways from sediments (Nasser, 1984) this led to a reduction in annual growth and its recent decline.

The changes in the region are heterogeneous in relation to space, time and distribution of land cover (Hamad *et al*., 2017). This phenomenon can be attributed to the rapid urban expansion, mainly due to population growth after 2003 (Musa, 2003); (Muhammad, 2013) Also, the decrease in rainfall resulted in negative effects on plant conditions (Eklundet Ssequist, 2015) with a shift in agriculture more than forests and biodiversity (FAO, 2010), in general, forest cover has been improved through better socio-economic conditions, new restrictions on fuel and firewood collection, which have been an energy source in the study area in past decades (Hamad *et al*., 2017).

The rates of change for a part of northern Iraq were presented and discussed based on analysis of low-precision time series, with reliance on information about land cover, land use change such as deforestation, renewal with other changes in land use categories and they were discussed in conformity with changes in natural forests, its potential impact on the availability of land for human activities such as agriculture, urban areas on the one hand and the preservation of biological diversity.

Materials and Method

Study Area

The study was conducted in the northern part of Iraq (Kurdistan Region) and it includes the governorates of Dohuk, Erbil and Sulaymaniyah. The study area is located within the eastern coordinates of 42^{o} 20' 59" - 44^{o} 03' 52" and within the widths of 36^{o} 42' 54" - 37^{o} 22' 49" with an area of 6893 square kilometers, fig. 1, the natural landscape is characterized by rugged terrain in most parts (Aziz, 2011), heights ranging from 376-415.3 meters, with slopes ranging from flat - 81 degrees, as for climate, the Mediterranean climate prevails in most of its parts, which is characterized by cold rainy winters, while summers are hot, dry and rain from November to April, the average annual rainfall is estimated at 1200 mm / year (FAO, 2008), in high folds, snow falls for 3-4 months, per year, with average temperatures from 4°C in January to 31°C in July and August, so the summers are hot, sunny, but winter is cold with the possibility of snow and frost.

Forests in Iraq

The forests of Iraq are almost confined to the mountains in the northeastern region of the country, which extends from the Zakho region near the Turkish border to the Hurin Sheren region on the Iranian border, within the longitudes of 42^{o} 40' - 45^{o} 30' and two latitudes 34^{o} 40' - 37^{o} 08', it constitutes 4% of the total area of Iraq (438466 square kilometers) and about 60% of the total mountainous area (30,000 km), in addition to narrow sectoral forests of 200 km growing along the main rivers (Nasser, 1984); (Sefik, 1981).

Forests are characterized by unique biological diversity, as valleys are mostly abandoned for agriculture or urban expansion (Etten *et al*., 2008), high mountain forests in Iraq are characterized by broad-leaved trees and evergreen conifers, such as deciduous oaks (*Q. brantii, Q. infectoria, Q. pubescens, Q. persica)*,

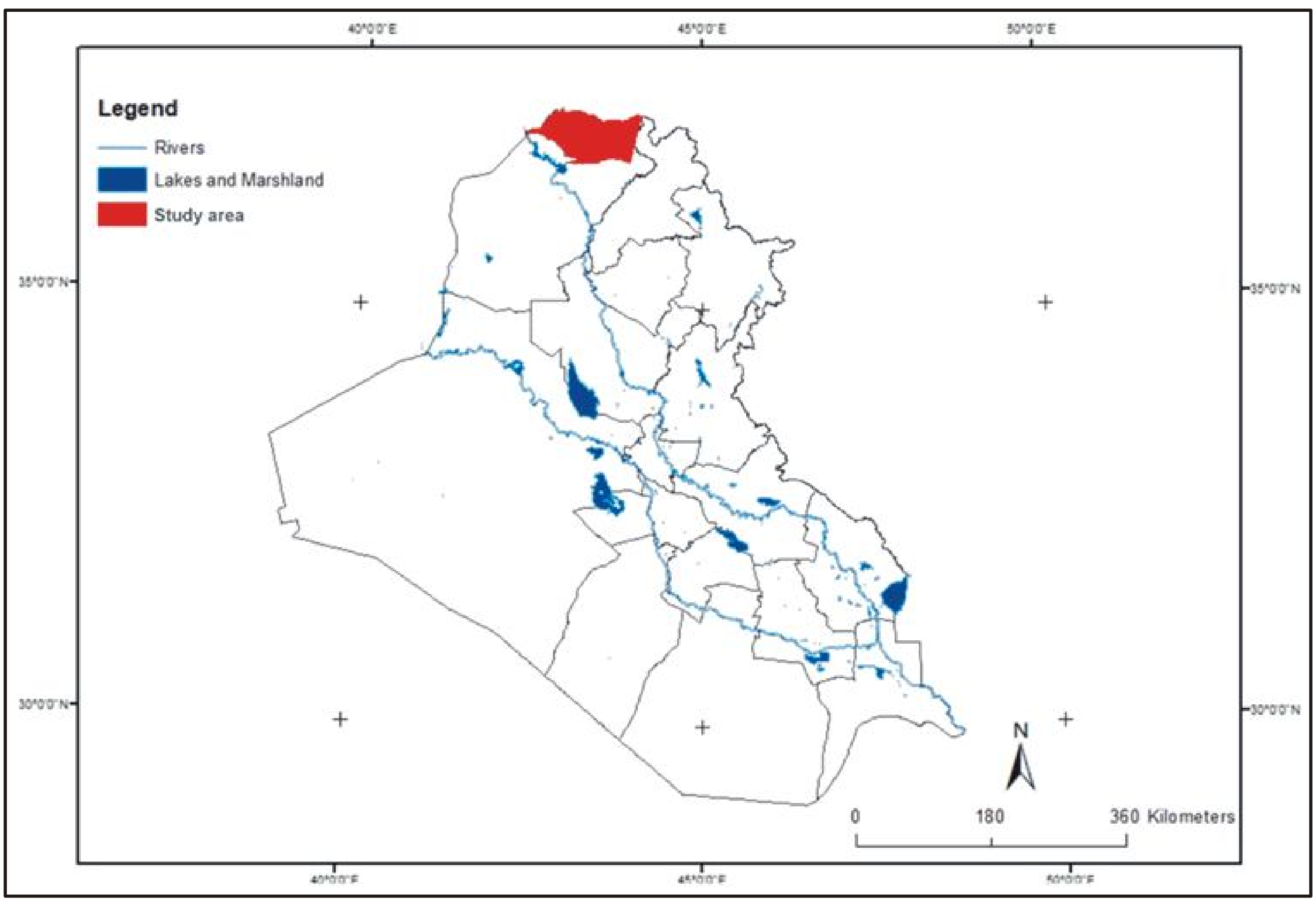

Fig. 1: Location of study area.

Table 1: Land Sat pictures with accurate spectral range of the Land Sat thematic scheme (OLI) and Land Sat imagery of lands.

Sensor	Acquisition Date and Time	Bands	Wave length (micrometers)	Resolution (meters)
LandsatThematic Mapper (TM)	1984 1998 2007	Band 1-Blue	0.45 - 0.52	30
		Band 2-Green	0.52 - 0.60	30
		Band 3-Red	0.63 - 0.69	30
		Band 4-Near Infrared (NIR)	0.76 - 0.90	30
		Band 5-Shortwave Infrared (SWIR) 1	1.55 - 1.75	30
		Band 6-Thermal	10.40 - 12.50	120* (30)
		Band 7-Shortwave Infrared (SWIR) 2	2.08 - 2.35	30
Landsat 8 Operational Land Imager (OLI)	2013	Band 1-Ultra Blue (coastal/aerosol)	0.435 - 0.451	30
		Band 2-Blue	0.452 - 0.512	30
		Band 3-Green	0.533 - 0.590	30
		Band 4-Red	0.636 - 0.673	30
		Band5-Near Infrared (NIR)	0.851 - 0.879	30
		Band 6-Shortwave Infrared (SWIR) 1	1.566 - 1.651	30
		Band 7-Shortwave Infrared (SWIR) 2	2.107 - 2.294	30
		Band8-Panchromatic	0.503 - 0.676	15
		Band 9-Cirrus	1.363 - 1.384	30
		Band 10-Thermal Infrared (TIRS) 1	10.60 - 11.19	100 * (30)
		Band 11-Thermal Infrared (TIRS) 2	11.50 - 12.51	100 * (30)

Juniper trees (*Juniperus excelsa, J. oblonga, J. phoetidissima*, *J. polycarpos*), lower elevations host almond (*Prunus amygdalus*), *Pistacia* and *Pyrus* species, *Pinus brutia, Quercus infectoria, Quercus libani*, Quercus (FAO, 2010).

Regional governments have made numerous attempts to manage forests by reforestation, controlling forest fires and stopping deforestation in various regions, which unfortunately have failed due to poor planning and lack of experience. This is also due to the responsible body involved in the strategic decision-making process, as Experts are generally excluded from these decisions except for some rare cases.

Remote sensing data

The Landsat Operational Imaging (OLI) image for 2013, TIRS Infrared Sensor with a spatial resolution of 30 meters and Thematic Imaging (TM) images for the years 1984, 1998, 2007 obtained at the same resolution of 30 meters. As the characteristics of the Landsat imagery used in this study are shown in (Table 1), all the Landsat imagery was downloaded from the (USGS), the images were selected in about the same season, with a reduced solar elevation effect in the case of the Landsat imagery.

Digital height data were also used to improve classification accuracy, especially to distinguish between bare rocks and urban areas, due to similarities in the reflectivity values between them, as urban areas have a slope less than rock slopes.

Methodology

Calibration and image correction

Image processing techniques are employed to improve the image to help with visual interpretation. Calibration treatment included in the work of relative radiometry has been included, to reduce radioactive differences between images caused by changes in surface reflection (Yuan, 2000); (Cosnefroy *et al*., 1996).

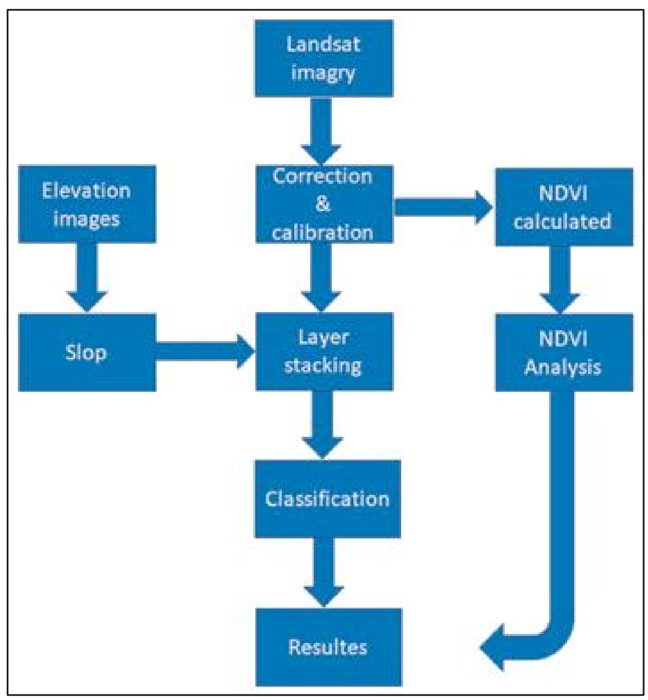

Fig. 2: Diagram Classification of Supervised to Correct Images with Land Use / Land Cover Maps.

These adjustments are important in ground cover ratings and for many other applications, such as photo mosaics or tracking vegetation indicators over time, accurate band production for a single scene and comparison of scenes from multiple dates and sensors, processing each spectrum of a multiple image (Chandr *et al*., 2013); (Mishra *et al*., 2014), all images are engineered to remove atmospheric effects on the reflection values of images, increase the accuracy of multiple time image analysis (Vermote *et al*., 1997); (Pacifici *et al*., 2014).

Image rating

Supporting data such as google earth, topographic maps and Landsat 3, 4, 5 ranges were used to identify the main land cover categories. These categories are water, forest, orchards, farmland, bare rocks, urban areas and rangelands (Fig. 4).

There is a resultant overlap between the bare rocks and the civilized areas through the convergence of their reflectivity values, because most urban areas are built with stones, but at a low slope, as the maximum probability classification for the study area (MLC) was applied (Asmala, 2012); (Sathya, 2017) (Fig. 2).

Calculation of the vegetative variation index

There are many concepts developed around the natural vegetative evidence and for many researchers who knew it was a digital value used to estimate plant characteristics such as the leafy area of the plant, the biomass and plant health, or it is quantitative measurements that explain the vegetative or biological activity of the plant, For the purpose of introducing variance in different indices, measurements must be incorporated at the infrared wavelengths (NIR) and red wavelength (R), especially in the early beginnings of plant growth, as it reflects a large amount of near infrared wavelength, these can be seen especially in the indices (Ideal VI).

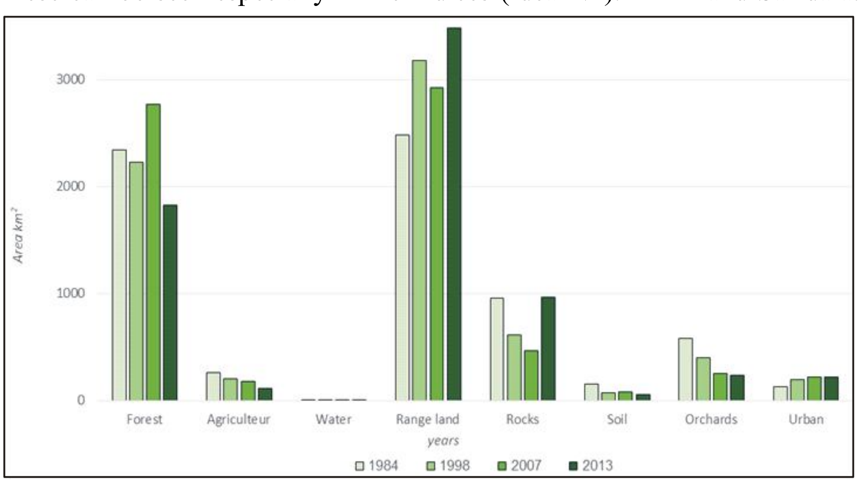

Fig. 3: Comparison of forest cover with other land cover for four periods.

There is a correlation between living mass, temperatures, annual precipitation, topography, sunlight and humidity angle, all of which control the spatial distribution of the living mass of trees and these factors will play a role in influencing the vegetative evidence.

Whereas there are some variables that are more closely related to the biomass of the vegetation cover, including forests, which are represented in both the top cover analysis (TCA-1), the top cover analysis (TCA-2), the top cover analysis (TCA-3), the simple ratio (SR) and NDVI, so there are many ways to calculate the vegetative evidence, as follows :

• The simple ratio:-

$$SR = \frac{NIR}{Red} = \frac{B4}{B3}$$

For the information, NIR is within the value (0.7 - 1.7), Red has a value (0.6 - 0.7) and the more the number of cells and layers of leaves leads to an increase in the value of (NIR).

Evidence of Natural Vegetative Variation (NDVI):-

It can be calculated from the following formula :

$$NDVI = \frac{B4 - B3}{B4 + B3}$$

There are other methods by which to calculate the evidence of natural vegetative variation, but the above two methods are the most used.

Results and Discussion

According to the supervised classification in the study area, accurate information on land use, the land cover map is necessary to detect long-term trend changes in the forest areas of Iraq and other varieties with it, this study aims to increase the accuracy of the classification of forest areas using the NDVI derived from The original Land Sat data.

Time series analysis techniques were used to assess vegetation degradation by estimating the Plant Cover Index (NDVI) in the Middle East and North Africa (MENA) region (Faour *et al*., 2016), they explained that the vegetation cover changes in Iraq between 1999 and 2012, as the ratios of 12.70% were negative, 83.34% unchanged, 0.85% positive change, Hot spot 2.59, bright spot 0.53, here the Landsat time series possesses a great ability to analyze land uses and land cover changes in Iraq (Al-Dosky *et al*., 2013).

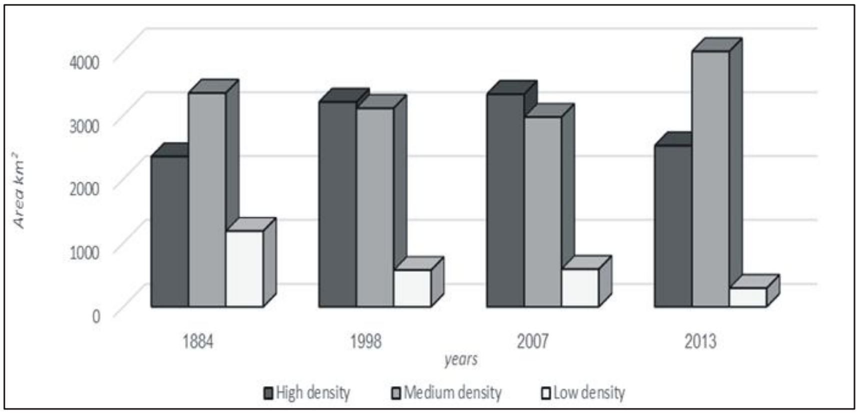

Fig. 4: Comparing the three forest density for four periods.

Maps of land use and land cover were prepared by programs of geographical information systems and landscape scales to determine, analyze changes that occurred over time in northeastern Iraq (Hamd *et al*., 2017), image objects were used as tree species mapping units to identify and select 15 types of trees in the Mangish sub-region, the Kurdistan Region of Iraq (Mustafa *et al*., 2014) and to map them with satisfactory accuracy in the urban areas of this study (Mustafa and others, 2015). This study assesses the state of forest change and discovers the rate of land use and changes that have occurred over the past two decades using supervised Landsat imagery, to produce vegetation change maps in northern Iraq.

Since over the past decades, especially for the period between 1980 and 2014, the fate of the Iraqi forests (like other activities of the country) was linked to the political situation, as this situation indirectly led to deforestation in northern Iraq (Etten *et al*., 2008), especially since Iraq fought four wars for the period 1980-2014 AD, at the rate of one war every eight and a half years, these wars exhausted the state of the country, especially the economic side, including agriculture and forests, the period 1990-2003 is the period most affected by forests due to the conditions of the embargo that the country went through, since many of the financial allocations that were made for forests were spent on the side of other projects not related to forests, the forest area between 1984-2015 was suffering from many fluctuations due to the human pressures on the forests that caused forest degradation, which was due to the over exploitation of the trees that were mainly used as fuel (Hamd *et al*., 2017). The fires also caused the greatest damage to the forests, with increasing demand for urban areas (Alkaradaghi *et al*., 2018), the shift to agriculture, grazing, cutting and other reasons.

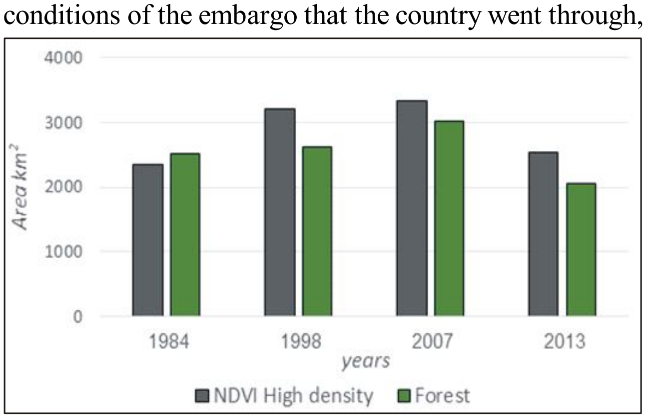

Fig. 5: NDVI values compared to the forest status for four periods.

Likewise, climate-related factors have also affected these forests, as Iraq (like other countries in the Middle East as well as the world) has suffered, especially during the last three decades of high temperatures, with little rainfall, as the rains have decreased by nearly half during these The period from previous periods from the history of Iraq (Mosa, 2016), forests of this effect had a great role. Through the use of the different readings of the channels for the different ground covers of the study area shown in table 1, we were able to estimate the variables that occurred for forests that can be observed through the space statement for the periods 1984, 1998, 2007 and 2013, as well as the forms (Fig. 3, 4, 5) that illustrate this change in terms of areas, whether for forests, agricultural areas, orchards, etc. We note the size of this change that changed the balance in the various activities of Iraq, from political, economic, social, urban and others.

References

Al-Doski, Jwan, S.B. Mansor and H.Z. Mohd Shafri (2013). Monitoring Land Cover Changes in Halabja City, Iraq. *International Journal of Sensor and Related Networks* (*I.J.S.R.N.*) **Volume 1**. https://www.academia.edu/4960912/Monitoring_Land_Cover_Changes_in_Halabja_City_Iraq.

Alkaradaghi, Karwan, Salahalddin Saeed Ali, Nadhir Al-Ansari and Jan Laue (2018). Evaluation of Land Use & Land Cover Change Using Multi-Temporal Landsat Imagery: A Case Study Sulaimaniyah Governorate, Iraq. In. https://doi.org/10.4236/jgis.2018.103013.

Asmala, A. and Q. Shaun (2012). (17) (PDF) Analysis of Maximum Likelihood Classification on Multispectral Data. Research Gate. 2012. https://www.researchgate.net/publication/279541271_Analysis_of_maximum_likelihood_classification_on_multispectral_data.

Aziz, Farhad (2011). Checklist of the Algae in Iraqi Kurdistan Region. *Salahaddin-Erbil Univ. Zanco J. of Pure and Applied Science.* **23 (janvier):** 31-72.

Chander, Gyanesh, Nischal Mishra, Dennis L. Helder, David B.

Aaron, Amit Angal, Taeyoung Choi, Xiaoxiong Xiong and David R. Doelling (2013). Applications of Spectral Band Adjustment Factors (SBAF) for Cross-Calibration. *I.T.G.R.S.,* **51(3):** 1267-81. https://doi.org/10.1109/TGRS.2012.2228007.

Cosnefroy, Hélène, Marc Leroy and Xavier Briottet (1996). Selection and Characterization of Saharan and Arabian Desert Sites for the Calibration of Optical Satellite Sensors. *Remote Sensing of Environment,* **58(1):** 101-14. https://doi.org/10.1016/0034-4257(95)00211-1.

Eklund, Lina and Jonathan Seaquist (2015). Meteorological, Agricultural and Socioeconomic Drought in the Duhok Governorate, Iraqi Kurdistan. *Natural Hazards,* **76(1):** 421-41. https://doi.org/10.1007/s11069-014-1504-x.

Etten, Jacob van, Joost Jongerden, Hugo J. de Vos, Annemarie Klaasse and Esther C. E. van Hoeve (2008). Environmental destruction as a counterinsurgency strategy in the Kurdistan region of Turkey. *Geoforum,* **39(5):** 1786-97. https://doi.org/10.1016/j.geoforum.2008.05.001.

FAO (2008). Irrigation in the Middle East region in figures – AQUASTAT Survey- Iraq. http://www.fao.org/nr/water/aquastat/countries_regions/IRQ/IRQ-CP_eng.pdf. 2008.

FAO (2010). Forests and Climate Change Working Paper 9. Food and Agriculture Organization of the United Nations Rome. 2010. http://www.fao.org/forestry/24646-0acdf8232cda6c92cb3e7b460f00fbea.pdf.

Faour, Ghaleb, Mario Mhawej and Abbas Fayad (2016). Detecting Changes in Vegetation Trends in the Middle East and North Africa (MENA) Region Using SPOT Vegetation. *Cybergeo/ : European Journal of Geography*, avril. https://doi.org/10.4000/cybergeo.27620.

Hamad, Rahel, Heiko Balzter and Kamal Kolo (2017). Multi-Criteria Assessment of Land Cover Dynamic Changes in Halgurd Sakran National Park (HSNP), Kurdistan Region of Iraq, Using Remote Sensing and GIS. *Land,* **6(1):** undefined-undefined. https://doi.org/10.3390/land6010018.

Ministry of Environment (2013). The National Environmental Strategy and Action Plan (2013-2017) for Iraq-2013 National_Environmental_Strategy.pdf. 2013. https://wedocs.unep.org/bitstream/handle/20.500.11822/8726/-The National Environmental Strategy and Action Plan (2013-2017) for Iraq-2013 National_Environmental_ Strategy. pdf?sequence= 4 & is Allowed=y.

Mosa, W.L. (2016). Forest cover change and migration in Iraq Kurdistan: A case study from Zawita sub-district. Michigan State University.

Mishra, Nischal, Dennis Helder, Amit Angal, Jason Choi and Xiaoxiong Xiong (2014). Absolute Calibration of Optical Satellite Sensors Using Libya 4 Pseudo Invariant Calibration Site. *Remote Sensing,* **6(2):** 1327-46. https://doi.org/10.3390/rs6021327.

Mohammed, Jambally (2013). Land Use and Cover Change Assessment Using Remote Sensing and GIS: Dohuk City, Kurdistan, Iraq (1998-2011). *International Journal of Geomatics and Geosciences,* **3(3):** 18.

Mustafa, Y. T., H. N. Habeeb, A. Stein and F.Y. Sulaiman (2015). Identification and Mapping of Tree Species in Urban Areas Using Worldview-2 Imagery. In *Proceedings of ISPRS Joint International Geoinformation Conference,* 28-30 *October 2015, Kuala Lumpur, Malaysia. Peer Reviewed Annals, Volume II-2/W2*, 175-81. https://doi.org/10.5194/isprsannals-II-2-W2-175-2015.

Mustafa, Yaseen T. and Hindav N. Habeeb (2014). Object based technique for delineating and mapping 15 tree species using VHR WorldView-2 imagery. In *Remote Sensing for Agriculture, Ecosystems and Hydrology XVI*, 9239:92390G. International Society for Optics and Photonics. https://doi.org/10.1117/12.2067280.

Nasser, M.H. (1984). Forests and forestry in iraq: Prospects and limitations. *The Commonwealth Forestry Review,* **63 (4 (197)):** 299-304.

Pacifici, Fabio, Nathan Longbotham and William J. Emery (2014). The Importance of Physical Quantities for the Analysis of Multitemporal and Multiangular Optical Very High Spatial Resolution Images. *IEEE Transactions on Geoscience and Remote Sensing*, **52(10):** 6241-56. https://doi.org/10.1109/TGRS.2013.2295819.

Sathya, P. and V. Deepa (2017). Analysis of Supervised Image Classification Method for Satellite Images. *Nternational Journal of Computer Science Research (I.J.C.S.R.)* **5(2):** 16-19. https://doi.org/ID: IJCSR-050204.

Sefik, Yavuz (1981). Forests Of Iraq. *Journal of the Faculty of Forestry Istanbul University | Ýstanbul Üniversitesi Orman Fakültesi Dergisi,* **31(1)**. https://doi.org/10.17099/jffiu.55526.

Vermote, Eric F., Didier Tanré, Jean-Luc Deuze, Maurice Herman and Jean-Jacques Morcette (1997). Second Simulation of the Satellite Signal in the Solar Spectrum, 6S: an overview ». *IEEE Trans. Geoscience and Remote Sensing,* **35:** 675-86. https://doi.org/10.1109/36.581987.

Wang, Cuizhen, Jiaguo Qi and Mark Cochrane (2005). Assessment of Tropical Forest Degradation with Canopy Fractional Cover from Landsat ETM+ and IKONOS Imagery. *Earth Interactions,* **9(22):** 1-18. https://doi.org/10.1175/EI133.1.

Yuan, D. and Lo. C. (2000). Relative Radiometric Normalization Performance for Change Detection from Multi-Date Satellite Images 107. Photogrammetric Engineering and Remote Sensing.