Impact of anthropogenic activities on natural vegetation cover of Aseer Region, Saudi Arabia

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IMPACT OF ANTHROPOGENIC ACTIVITIES ON NATURAL VEGETATION COVER OF ASEER REGION, SAUDI ARABIA

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Abstract

Aim: This study aims to monitor the degradation of natural vegetation cover (particularly in juniper trees' ecosystem) in one of the richest areas of biological diversity in the Kingdom of Saudi Arabia caused by intensive anthropogenic activities.

Location: Aseer area located in the southwestern part of Saudi Arabia, it extend between the latitudes of 17° 30´: 21° N and the length of 41° 30´: 44° 45´ with total area about 84,084 km2.

Methods: Satellite images analysis were used to detect the changes in natural vegetation cover in the study area. These satellite images covering the period between 1980 and 2020.

Results: The total area covered with natural vegetation was 4385.6 km2 in 1980; it deceased to 3645.5 km2 according to the satellite image of 2020. Population growth and urban sprawl were the main factors causing the degradation of natural vegetation cover in this region.

Keywords: Biodiversity; Juniper trees ecosystem; Aseer; Natural vegetation cover; Abha urban area; Human activities.

Introduction

In Saudi Arabia, there are about 2,250 plant species, represent 132 plant families and 837 genera, of which 105 species grow in sand dunes, 90 species of saline plants, 75 species of trees, and 12 species of aquatic plants. Endemic local species in the southwestern region are the most abundant of plant content and more abundant in endemic species (National Commission for Wildlife Protection and Development, 2005)

The study found that juniper is the main plant in the study that is affected by the intensity of rain and the height factor. It is a tree that has features similar to the tree that grows in the Mediterranean region; it is known there under a different local name.

It has been possible to classify plants and tree species in the area into the following categories: The first group is represented by Juniperus Procera; The second group includes juniper trees, wild olive trees, and other plants; The third group includes Acacia ssp and Acacia trees, europea ssp barbeya oleoides domestic; and The fourth group is the Acacia forest, wild olive trees, and other communities. (Ministry of Agriculture 2007)

The current rate of human-induced species extinction is believed to be far higher than the commonly estimated background rate of extinction, The study area includes a unique diversity of vegetation, with approximately 55% of endemic species that live in Saudi Arabia, Uncertainties exist in the cause–effect relationship between responses, pressures, states, and benefits. Imperfect indicators in each focal area may magnify these uncertainties. Consequently, there will be a need for an adaptive management approach for interpretation and use of indicators, in which both the responses and the effort put into them are modified iteratively according to outcomes.

The author aims to assessment the degradation of the total area of natural vegetation by analyzing the human factors that cause this degradation.

Study area

Aseer area located in the southwestern part of Saudi Arabia, it extend between the latitudes of 17° 30´: 21° N and the length of 41°30´: 44 ° 45´ with total area about 84084 km2.(as shown in fig 1).The physical characteristics of the study area left its effects upon the climatic features so Rainfall ranges from 238 to 500 mm per year. In the study area, rainfall occurs in the spring and early summer months; the study area is exposing to the southwestern wind; and the highlands are a catalyst for major rainfall.

A- Topography

The topographic distinction of the Aseer region has brought many of the justifications that have made the region an attraction of tourism; it ranges between the heights of the Asir Mountains, in which Jabal Al-Souda is recorded, the highest mountain peak in the Kingdom (3200 meters), and the plateau range, passing through the coastal plain (Tuhama Asir), up to the valleys that extend as deep, steep lines that cut paths from the mountain fronts, paths to it, As figure (2) illustrates

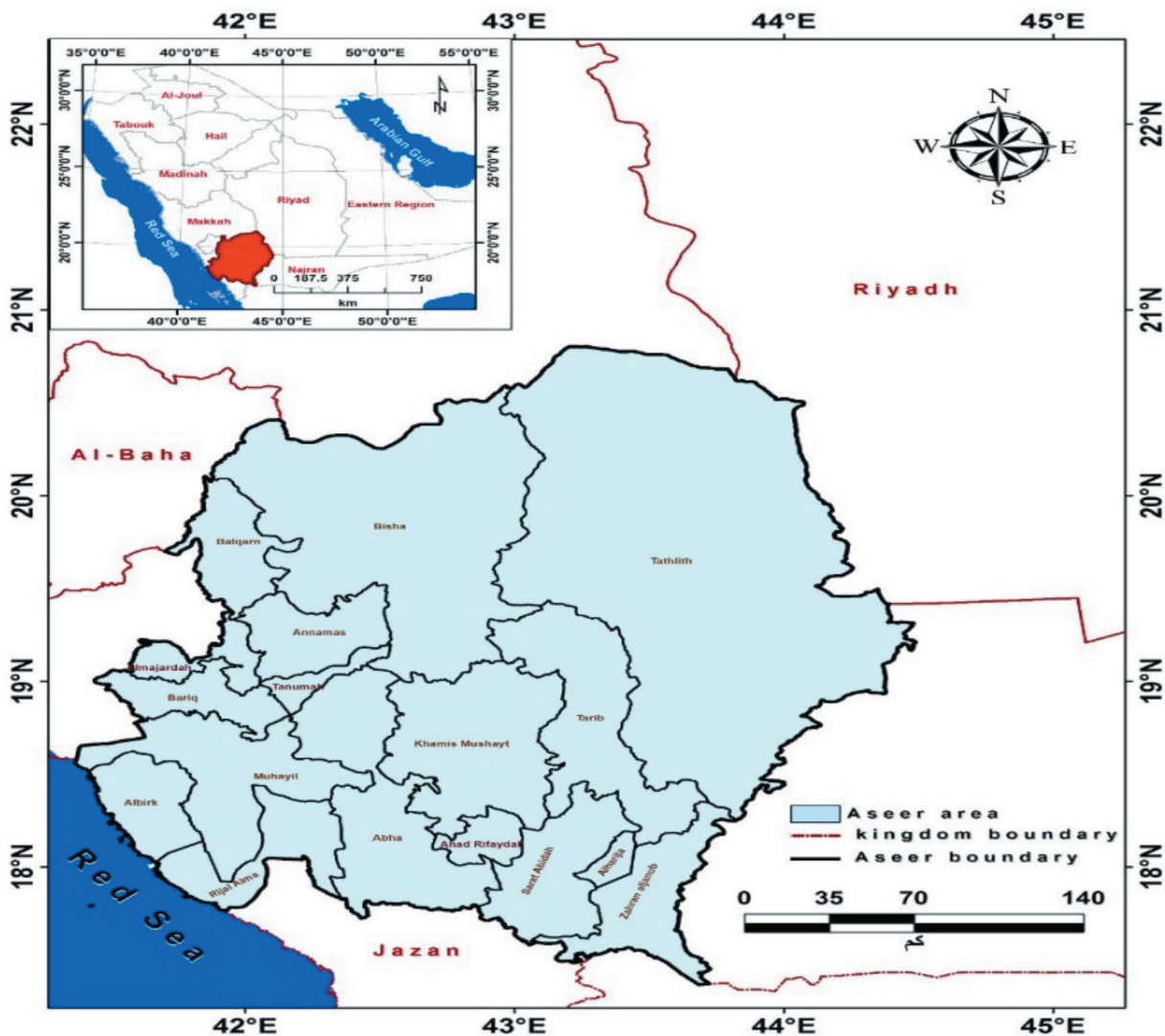The following geomorphological units can be distinguished in the area:

Fig. 1. Location of Aseer region.

- Tihama Asir

It is the area confined between the Sarat Aseer Mountains and the Red Sea coast, which extends from the western slopes of the Sarawat mountain range, with a distance of approximately 150-170 km, and constitutes approximately 17.5% of the Asir region.

- Mountain heights and hills

Mountain heights and hills, which can be classified into:

- Heights of the Sarawat Mountains (Sarat Aseer Mountain Range)

Its area represents about 34.3% of the area of the Aseer region, and it forms a mountain belt with a height of 1400 meters or more above sea level, extending parallel to the Tihama Plain and the Red Sea.

- The Eastern Plateau (Aseer plateau)

It is a semi-flat land that represents approximately 48.2% of the Asir region, and its surface slopes gradually towards the east and north according to the inclination of the geological base, and its height from (600 to 1400 meters).

- Wadis

Aseer region is characterized by its possession of a large number of wadis in which water flows during rainy periods, and is characterized by dense and varied vegetation cover, Among the most important of these wadis are: Bisha, Utud, Helli, and Tathleeth.

The physical characteristics of the study area left its effects upon the climatic features so Rainfall ranges from 238 to 500 mm per year. In the study area, rainfall occurs in the spring and early summer months; the study area is exposing to the southwestern wind; and the highlands are a catalyst for major rainfall

B- Climatic Conditions

The physical characteristics of the study area left its effects upon the climatic features so Rainfall ranges from 238 to 500 mm per year. In the study area, rainfall occurs in the spring and early summer months; the study area is exposing to the southwestern wind; and the highlands are a catalyst for major rainfall

Temperatures in the Asir region are generally moderate, with the effect of altitude. High regions moderate its temperature in summer, and decrease in winter, it is rarely reach zero, in elevations with a height of more than 2,600 meters, and low areas hotter in summer. Therefore, the average annual temperature varies from region to region. The annual average temperature in the region is about 22 degrees Celsius,

The amount of rain ranges between 238-500 mm annually, and rains fall in the spring and early summer, due to the region's exposure to the south-west winds, and the presence of highlands as a catalyst for large amounts of rain.(General Authority for Meteorology and Environment,2018) The most prevalent trees in the region are the juniper forest, followed by a density of Acacieae trees, Acacia tortilis, and Acacia ehrenbergiana.

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Environment,2018) The most prevalent trees in the region are the juniper forest, followed by a density of Acacieae trees, Acacia tortilis, and Acacia ehrenbergiana.

C- Natural Vegetation

The dominant vegetation is this area primarily consists of juniper trees, as well as different species of broad-leaved plants such as domestic neem. However, each sub-region within this area has its own characteristics. The region is dominated by sparse to medium density tree cover that primarily includes juniper trees

The most important areas of the spread of tamrix in the region of Balqarn, on the western slopes of Abha Heights, another species are scattered in the valleys of Tihamat Asir as well as in the valleys of the Sarra and the plateau. As for Acacieae trees, Acacia tortilis trees, Acacia trees, and Salvadora australis shrubs, they are frequent in Tihama and in the highlands and plateau regions. However, the acaieae trees are spread in some areas of the plateau to the east of Khamis Mushait.(National Wildlife Conservation Authority, 2005)

Material and Methods

.As this study relies on directed change analysis, it is a valuable technique for detecting changes that affect both land use and coverage patterns. It can also help determine a reasonable identification of large changes and the direction of these changes.

Satellite images analysis is one of the most important methods used to detect changes in the Earth's surface. The most important results of this cartographic method can be summarized in the following two examples.

First involves the changes that occur in the Earth's organization as a result of human activities. This may mainly be related to the economic activities, such as increase in the population that causes other expected changes the patterns of use of the land and its body. (Keith N. Muhlestein, (2008) The second is that urban growth, especially population movements and commercial activities, will transfer urban attributes to rural areas, thus negatively impacting the ecosystem. (Squires, G.D. 2002)
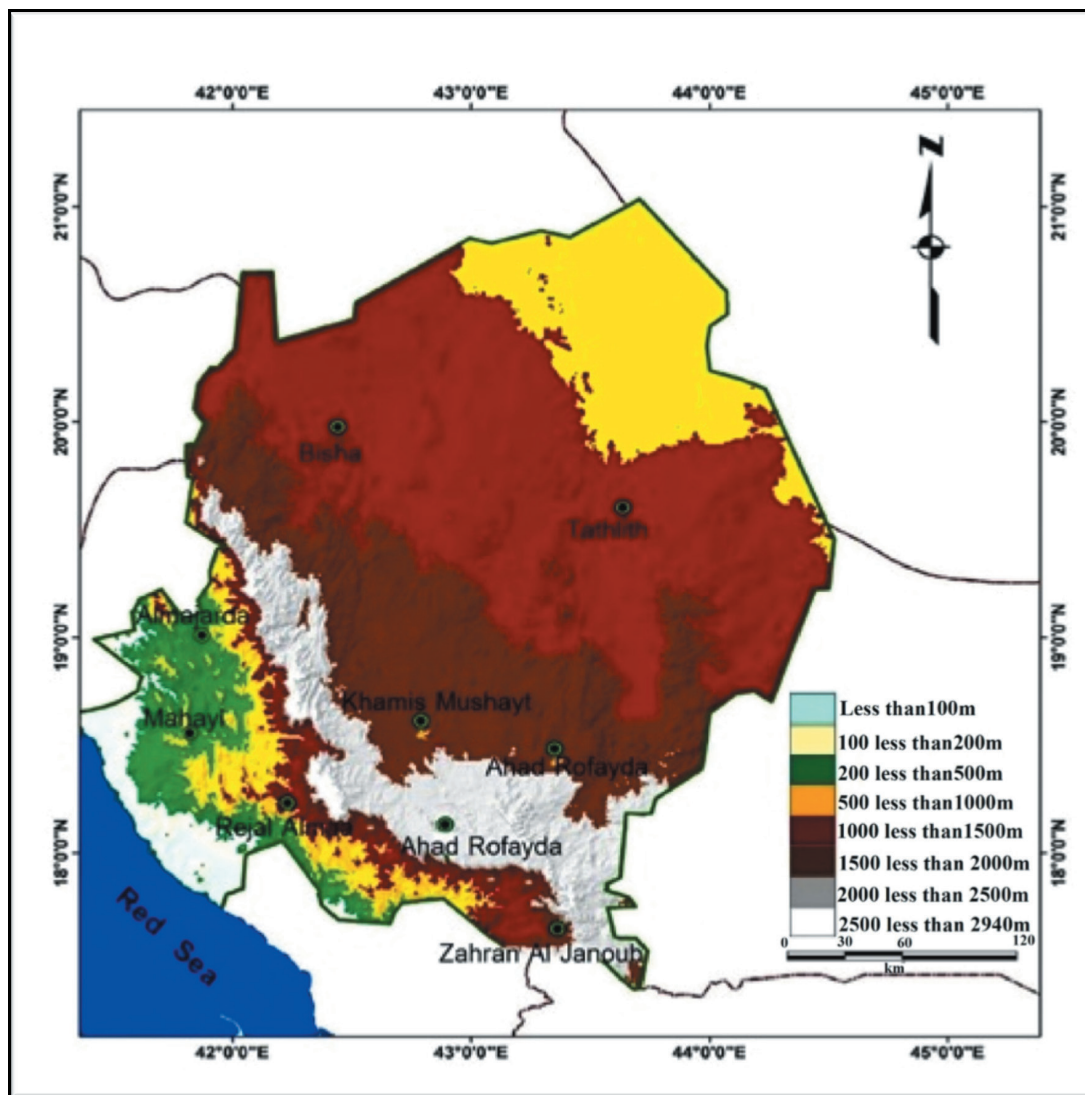
Fig. 2. Topography of Aseer region.

The processes of monitoring and measuring these changes are indispensable aspects for reaching a deeper understanding of the mechanism by which such changes take place, as well as the modeling the effect of this change on the environment and on the associated ecosystems at different levels.((Keith N. Muhlestein, 2008)

This is remote sensing technology is a suitable source through which levels of change can be extracted with efficiency in terms of both land use and its coverage pattern over the past two decades. Moreover, there is a growing trend in the development of technologies that can help detect changes through remote sensing technology.

The current study uses satellite images from the Landsat series, where satellite imagery was used as follows:

• Five images from the Landsat 5 satellite, which carries a Thematic Mapper, were used from March and April 1990. The imaging consists of 7 spectral waves with a resolution of 30 m, with the exception of the sixth heat wave which has an accuracy 120 m.

• Five Landsat 7 (ETM +) images were used from the same months of the previous satellite in 2000. Table 2 shows the characteristics of this satellite.

• Five images were used from Landsat 8 satellite, which carries two scanners (OLI & TIR) from 2019, and the video consists of 11 spectral waves

Updating the database using geographical information systems and remote sensing, on the other hand, requires exploring recent changes. This largely depends on the sequence and continuity of economic and urban changes and the process of socio-economic development in the region.

Objectives :

The author aims through this study to achieve the following objectives:

A- Assessment of the natural vegetation cover in the study area.

B- Determine the anthropogenic factors which causing the quantitative degradation

C- Analyzing the mechanism of the occurrence of natural vegetation

Previous studies:

The Author reviewed studies that dealt with similar topics to the subject of this study, in terms of the impact of human activities on the environment, especially the natural vegetation cover; the most of them, among the most important of those studies are the following:

In 2002 Michael Bredemeie, discussed the Anthropogenic Effects on Forest Ecosystems at Various Spatio-Temporal Scales, In this study, the long-term effects on forest ecosystems that are subject to human influences were analyzed by discussing several axes, the most important of which were the following two:

a- The history of exploiting forests and converting them into urban expansion areas

b- Current global loss of forests and soil degradation.

Although deforestation is a prevalent phenomenon in developing countries, it threatens vital resources and soils on a global scale. The study concluded that the developed countries have implemented exactly such practices in their history, something that the least developed countries have not achieved, which is linked to the increase and continuation of the demand for food in light of the continuing high population growth rates in these regions.

Belal and Moghanm (2011) introduced a study titled "Detecting urban growth using remote sensing and GIS techniques in Al Gharbiya governorate, Egypt", Two land sat images, Multispectral Scanner (MSS) in the 1972 and Enhanced Thematic Mapped (ETM) in the 2005 were used to assess the changes of agricultural lands, urban encroachment and water areas during this period with integration by GIS. The agricultural areas in Tanta and Quttour decreased by 7.17% and 5.84%, respectively from the year 1972 to 2005, while the urban areas increased by 7.17–5.84%, respectively. This urban expansion causes loss of productive agricultural lands.

Al qurashi and Kumar (2015) discussed "Land Use and Land Cover Change Detection in the Saudi Arabian Desert Cities of Makkah and Al-Taif Using Satellite Data" this study evaluates LULC change in Makkah and Al-Taif, Saudi Arabia from 1986 to 2013 using Landsat images. Maximum likelihood and object-oriented classification were used to develop LULC maps. The change detection was executed using post-classification comparison and GIS. The results indicated that urban areas have increased over the period by approximately 174% in Makkah and 113% in Al-Taif. Analysis of vegetation cover over the study area showed a variable distribution from year to year

Michael J. Kennish, 2015. Present a study titled, Anthropogenic impacts, where it identified a wide range of anthropogenic factors contribute to the degradation. Among of them are (1) nutrient loading and multiplication; (2) Sewage and organic waste, (3) Habitat loss and alteration, coastal hardening, and erosion;

(4) Chemical pollutants. (5) Human-induced sediments/ particles,(6) overfishing and intensive aquaculture.

Rahman, 2016, discussed the Detection of Land Use/Land Cover Changes and Urban Sprawl in Al-Khobar, Saudi Arabia: An Analysis of Multi-Temporal Remote Sensing Data, the author uses remote sensing data to examine the decadal land cover changes in Saudi Arabia's eastern coastal city of Al-Khobar between 1990 and 2013. Specifically, it utilized ISODATA classification method to classify Landsat TM, ETM+, and OLI data collected from 1990, 2001, and 2013 and then detected changes in the land cover within the study area. With overall classification accuracies greater than 85%, the results show that urban built-up areas increased by 117% between 1990 and 2001 and 43.51% from 2001 to 2013. Vegetation increased by 110% from 1990 to 2001 and by 52% between 2001 and 2013. The entropy index values of 0.700 (1990), 0.779 (2001), and 0.840 (2013) indicates a high rate of urban sprawl and the city dispersing near the outskirts and towards the neighboring cities of Dhahran and Dammam.

Rad, et al, (2018) presented a study entitled "Effects of anthropogenic disturbance on plant composition, plant diversity and soil properties in oak forests, Iran". where explained that the increasing the intensity of destruction of number of species will decrease and the community structure and species composition will change, As the anthropogenic impacts reduced the amount of organic matter of the forests soil, The study has concluded recommending the need to implement a program to conserve forests in this region.

The author has benefited from the research methods and study methods adopted by the authors in these studies, and the results of our current study are consistent with many of the results of these studies regarding the decline of vegetation cover because of inappropriate human activities, the most important of which were population growth and urban sprawl.

Results

- Through the last five decades, the study area has been exposed to intensive human activities that has led to significant changes in the total area of natural vegetation and its spices composition.

- The total area of vegetation cover in Aseer area was 4385.6 km2 in 1980 and has decreased to 3645.5 km2, according to the satellite image of 2019.Figures (3 & 4) show the degradation in vegetation cover of Aseer region was nearly 44.000 km2,in 1984, but has now, according to the recent satellite image of 2020, has shrunk to nearly 36.000 km2. In other words, the study area has lost nearly 8000 km2 of green cover.

In more details in some sites inside the study area we found that :

1- A distinct case of natural vegetation degradation also evident directly resulting from anthropogenic impact in the Abha urban area (the largest urban area in Asir that includes three big cities: Abha, Khamis Mushayt, Ahad Rofida).

This is shown in figure (5) the area occupied by natural vegetation in 1970 was estimated to be 754.1296 km2. It then declined in 2010 to 648.1339 km 2, which is approximately 15% less than that in 1970. An analysis of the satellite image of 2020 showed that the contraction reached the greatest extent of approximately 47% more than in 1970 with an estimated

The three cities involved in the study area, which are Abha, Khamis Mushayt, and Ahad Rafidah, formed a small area of approximately 28 km2 in 1980. This then increased within
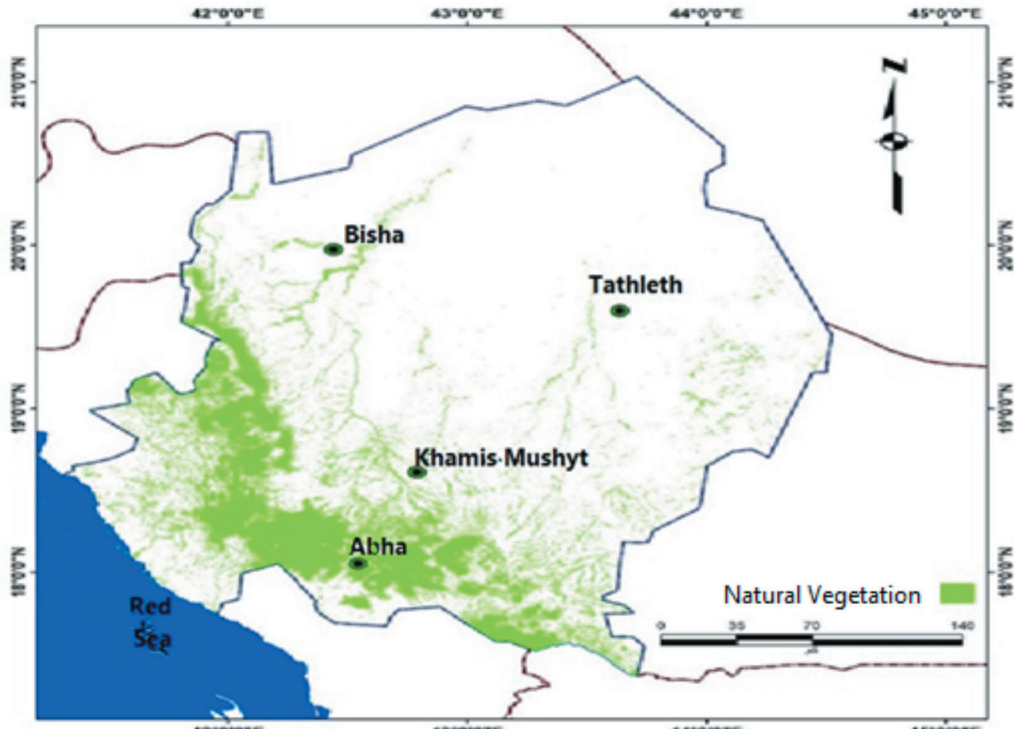
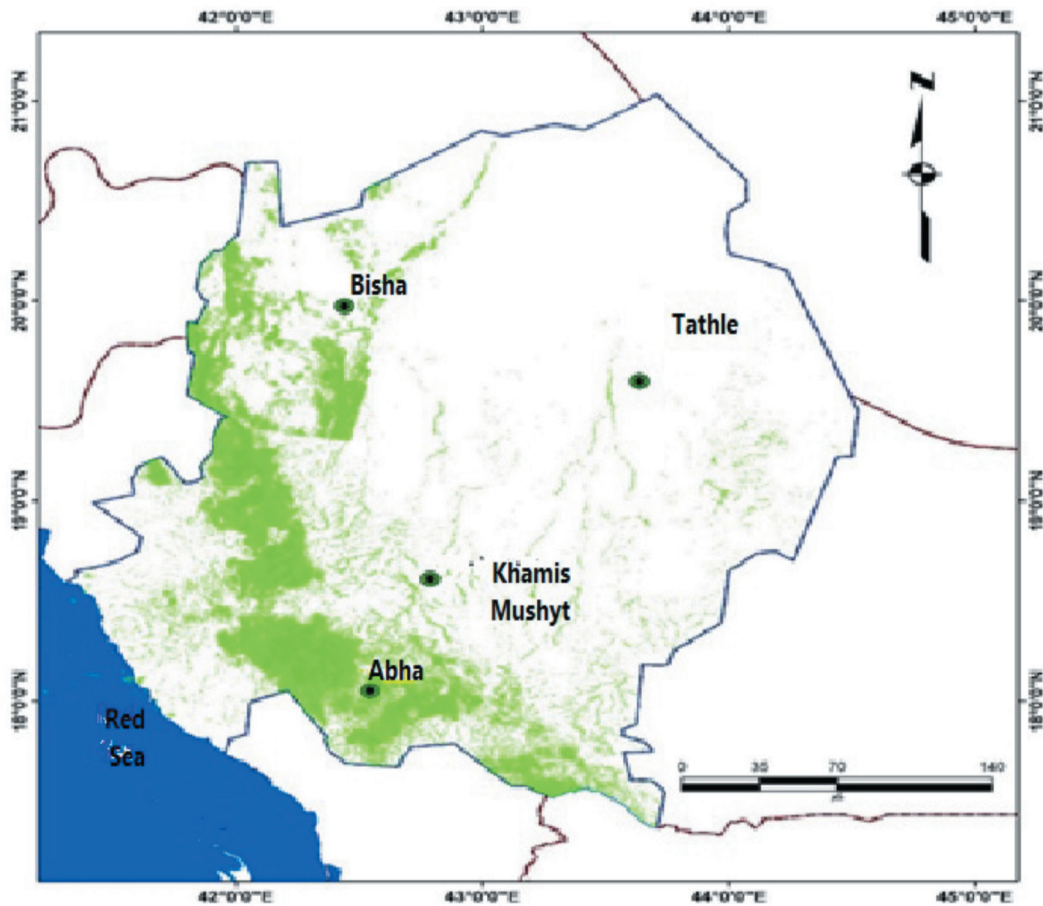*Fig. 3. Cover of natural vegetation in the study area during 1984.*

Fig. 4. Cover of natural vegetation in the study area during 2020.

five years to reach the extent of multiplication registered at approximately 56 km2 and continued to increase up to 129 km2 in 1990, representing the period from 1980 to 2020 that recorded significant leaps in the growth of urban mass, As figures (6&7) illustrate.

2- In Bisha Governorate, According to the results of satellite images analysis which shown in Fig (8) the total area of natural vegetation decreased from 184.2 km2 in 1984 to 82.2 in 2020. At the same time the built up area was increased from 6.4 km2 in 1984 to about 195 km2 through the same period (1984: 2020) as show in Fig (9).

Discussion

It can be said that human activities are the mainly responsible for the degradation recorded in the study area.

Population Growth, urbanization, changing socioeconomic characteristics of the population, and the administrative regulations and laws are the most effective factors that have led to the degradation of the natural vegetation cover of the study area.

1- Population Growth

Population growth requires the construction of residential and commercial areas, public facilities, and new modes of transportation. This also involves a shift in the original use of forest lands, agricultural lands, and fragile soils, thus ultimately causing changes in both land use patterns and land cover patterns, and then the occurrence of urban sprawl (Muhammad Rahman, 2016).
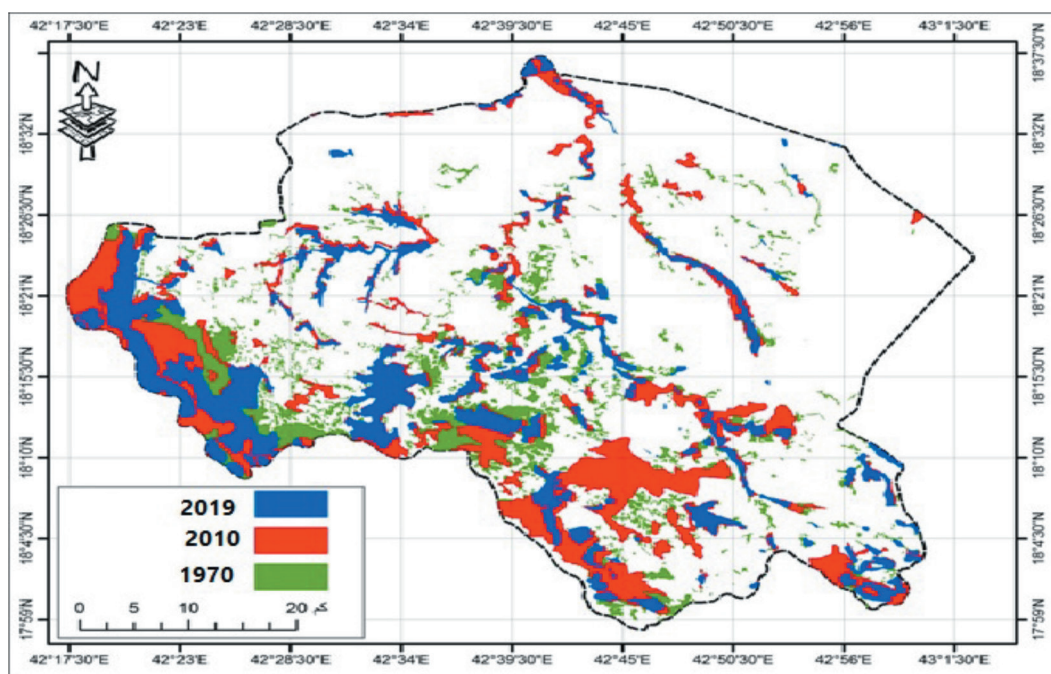

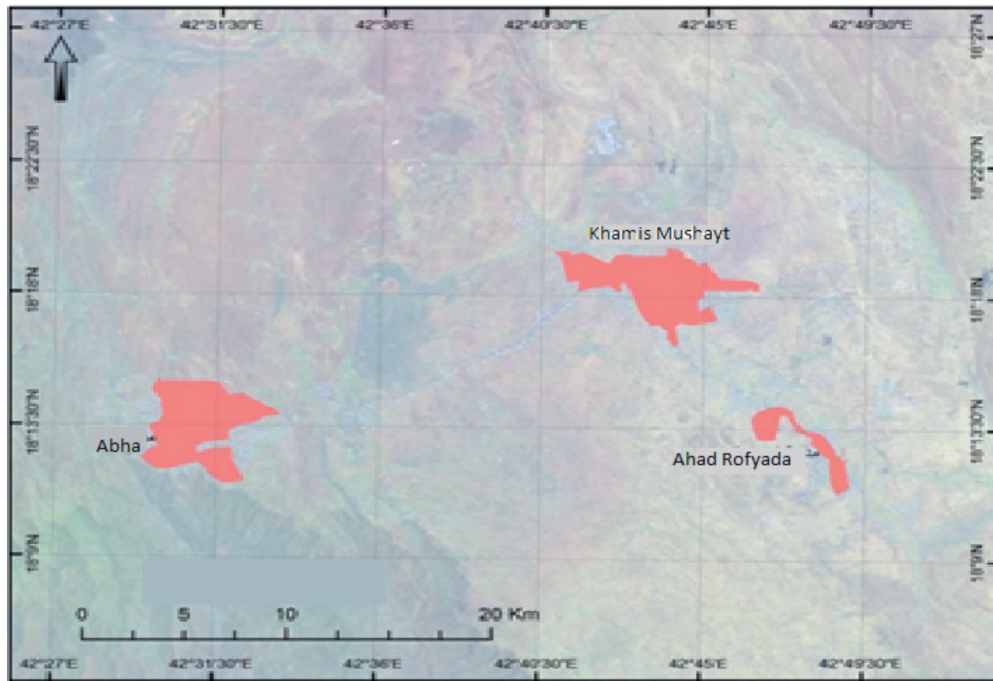*Fig. 5. Changes of natural vegetation cover in Abha urban area between 1970 and 2020.*
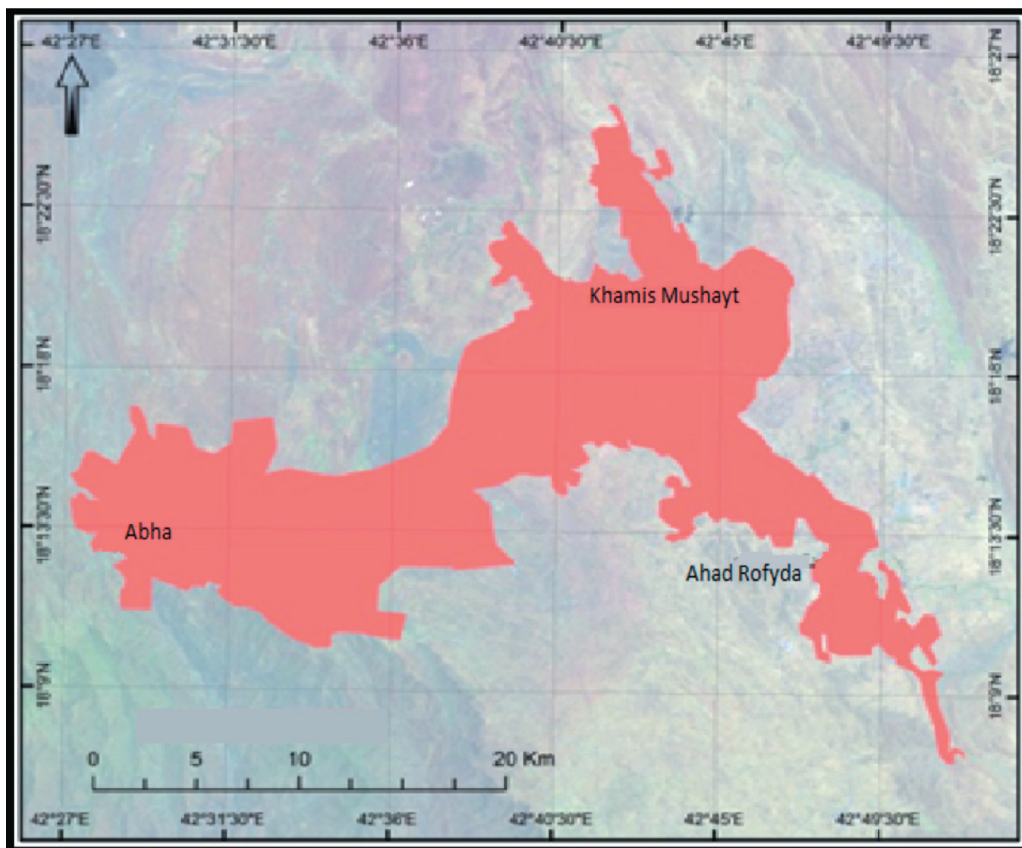
Fig. 6. Abha urban area during 1985.

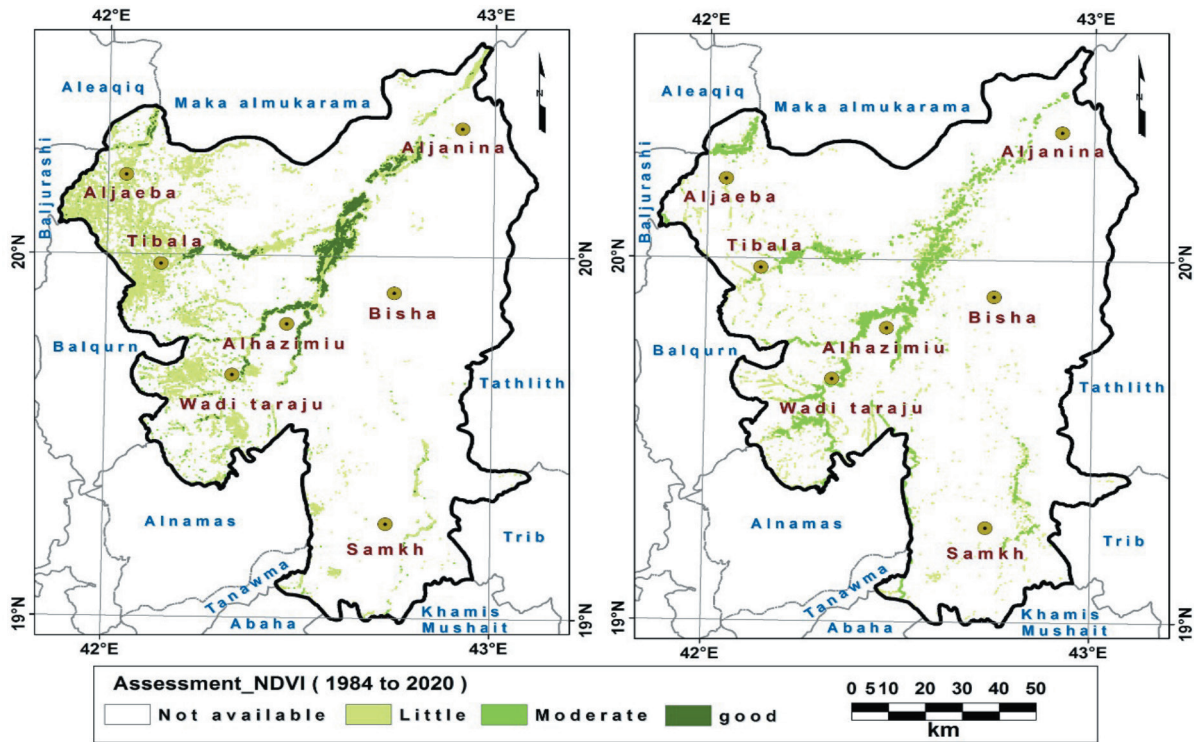
Fig. 7. Abha urban area during 2020.

Fig. 8. Decreasing of natural vegetation in Bisha Governorate between 1984 and 2020.
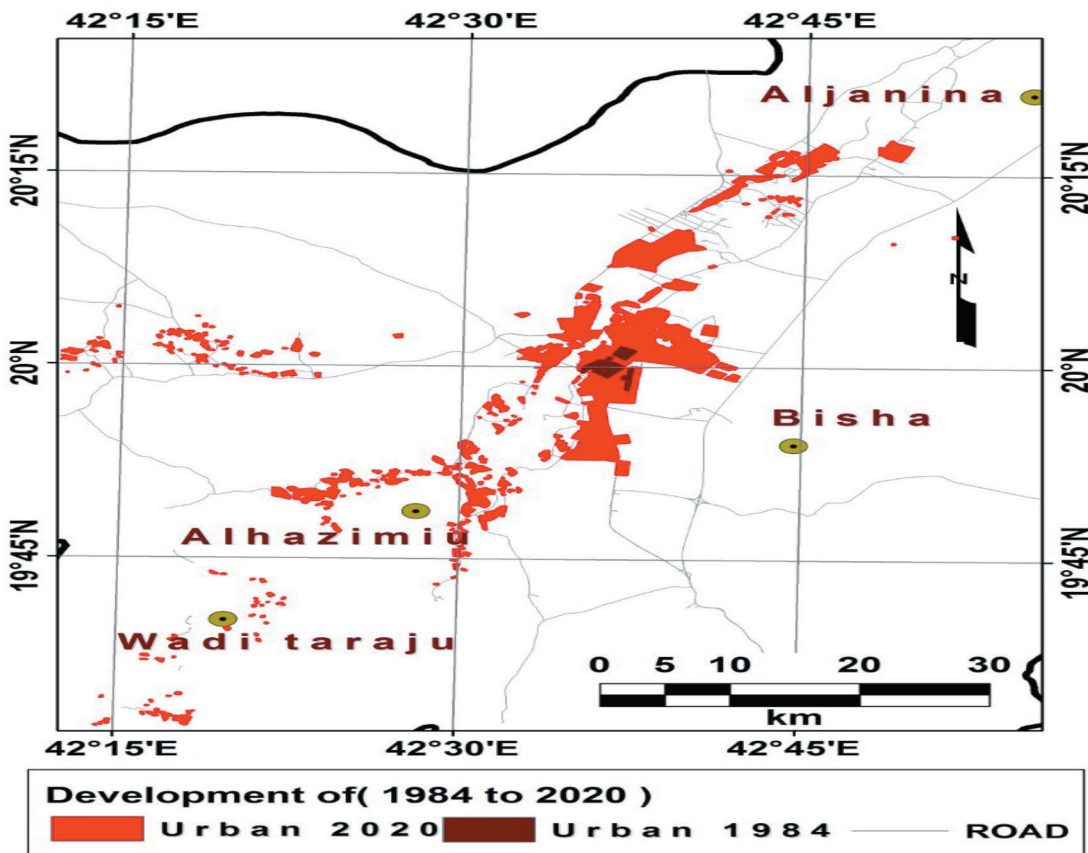

Fig. 9. Increasing of urban area in Bisha Governorate between 1984 and 2020.

Figure (10) shows the increase in the population of the study area from 1990 to 2019, in just over a quarter of a century. The total population increased from about one million and half in 1990 to more than two millions and four hundreds thousand, according to the latest 2019 population census.
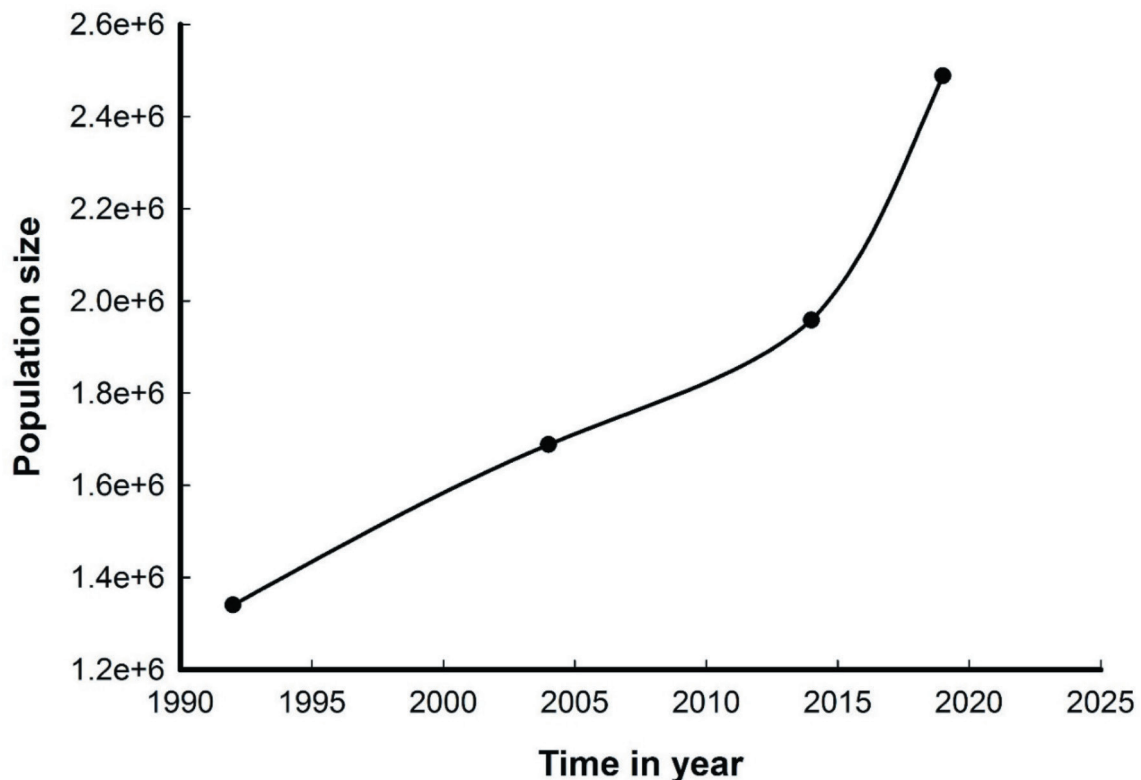

Fig. 10. Population growth in Aseer region between 1990 and 2020.

2- Urbanization

In general, urbanization is a vital process that results from economic development, accelerated population growth, and high rates of population density, This puts pressure on the populated areas and thus determines the direction and rate of change affecting the landscape. It is very important for development planners to define a policy for specific use of the land (Shalaby, A , Moghnam F A, 2015).

Figures (6-7) show a huge rate of urban sprawl on the forests area that have increased from (45 km2) in 1970 to (485 km2) in 2020, in Abha Urban Area, and Fig (9) illustrate how the built up area of Bisha Governorate has expanded in about 36 years to an average of about 5.4% per year.

The term urbanization generally refers to the increase in both the population and the associated construction of residential settlements, and thus includes the increase in the number and size of the cities, as well as the population movement to the urban areas. .(Muhammad Rahman,2016)

3- changing socioeconomic characteristics of the population

A large number of people moved from doing pastoral and agricultural work to service. This transformed people's lives into one with

stability and urbanization, in addition to what represented by the abnormal increase through waves of migration to the region to work in various economic sectors as a primary source of this demographic change.

The economic leap (1974–1985) in the Kingdom of Saudi Arabia that resulted from the huge financial returns for oil production led to a clear change in the lifestyle and in economic and social characteristics of the population.

Statistical data indicates that the percentage of workers involved in agricultural, pastoral, and related sectors decreased by more than 10%, as per the census of 1990, and decreased from 16% to 6%, according to the results of the 2019 census.

4- Administrative regulations and laws

Due to the nature of the region, the agricultural activity in that are depended on the rain and underground water, Which was sometimes not enough to irrigate the land and ensure the success of the cultivation activity, The oscillation of rainfall led to failure during some agricultural seasons, as observed during the 1990–1991 season.

With the farmers' complaining about the lack of water resources available for agricultural operations and the desire for a large sector of these farmers to transfer their lands from being "agricultural land or arable land" into the urban land category, this area was considered suitable for construction. The legislation issued on November 4, 2014 recommended and allowed "the transformation of agricultural lands as there is insufficient water available to ensure the success of agricultural operations for urban use." This was in accordance with the report of the technical committees concerned with the application of that law.

The data of the Saudi Ministry of Agriculture indicates that during the period from 2014 until In 2019, that is, since the enactment of this legislation, it has been approved to transfer about 88 km2 of agricultural land to land suitable for construction, which accelerated the pace of change in the land use of the study area. (Aseer Region Municipality, Water and Agriculture Department, 2019)

On the recommendation of a committee of experts from the water and agricultural sectors, this legislation became an opportunity for landowners who wanted to convert their land into building land or allow it to be used for construction.

Acknowledgements

Conclusion

This study showed how the natural vegetation cover in the study area was facing numerous problems that led to it losing vital components of the ecosystem.

The natural vegetation suffered from human activities, and the study area lost approximately 750 Km2 of its green cover over the last five decades.

Population growth and the urbanization can be considered as the factors that had the most impact on natural vegetation.

It should be noted that the study area is a candidate for losing more of its bio-components, and thus, it is necessary to make more efficient and effective efforts towards conservation and preservation of the ecosystem.

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