Ecology

THE IMPACTS OF THE OIL INDUSTRY DEVELOPMENT ON THE VEGETATION COVER IN THE OIL PRODUCTION AREAS IN WESTERN KORDOFAN STATE, SUDAN

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Abstract. The oil industry's development follows a series of steps and processes, including exploration, drilling, and oil infrastructure, which affect vegetation in different ways. This study aims to investigate the role of the oil industry's impact on vegetation in oil production areas in the state of West Kordofan, Sudan. To achieve this aim, the study used satellite images and geographic information systems (GIS and ERDAS) to analyze and calculate the area of vegetation cover in the study area compared to other land uses. In addition, the study used secondary data and the field observation method. The study found that there is a clear impact of the development of the oil industry on the area of vegetation, especially around oil fields and settlements. The area of vegetation also declined from 56% in 1999, at the beginning of oil production, to 42% in 2023 of the total other land use in the region. Therefore, the study recommended paying attention to evaluating the environmental impact and practicing reforestation to compensate for the removal of vegetation in the study area.

Keywords: *Satellite images, land uses, economic activities, environment.*

Introduction

Vegetation is subjected to a continuous process of removal due to the need of humans to expand their economic activities to meet their daily needs. The oil industry is among the economic activities that require the removal of vegetation because it consists of a series of stages, starting with exploration, drilling, and other logistical services related to the oil industry [2], [6].The impact of removing vegetation cover for the purpose of developing the oil industry is double in areas with fragile vegetation cover, as is the case in dry and semi-arid environments, where vegetation cover is scarce, especially large trees, and thus the ability to compensate for the loss becomes very difficult.

The oil countries in sub-Saharan Africa, such as Nigeria, Chad, and Sudan, for example, which are countries located within what is known as the African Savanna Belt, suffer from a continuous loss of vegetation because of the expansion of oil industry activities, as tens of hectares of vegetation are removed to establish a new oil field or a new pipeline to transport oil [12].

Sudan is located within the arid and semi-arid tropical region, and this has provided Sudan with a diversity of vegetation cover (*look at figure 1)*, ranging from desert in the north, passing through semi-desert in the center, and ending with rich savannah in the south. The latest statistics estimate that the forest area in Sudan is estimated at about 183,600 square km, but it is constantly declining due to economic activities, including the oil industry. The latest statistics estimate that the forest area in Sudan is estimated at about 183,600 square km, but it is constantly declining due to economic activities, including the oil industry [5].

According to Harrison and Jackson (1958), the vegetation of the study area, ecologically classified as Combretum cordovanum (Glutinosum) - Dalbergia - Albizia cericocephala (Amara) and savanna woodland, is a subdivision of the Loo area. Woodland Savannah rainfall over the sandy area. This subdivision occurs in areas of rainfall ranging from 450 - 600 mm/year [5].

The ground cover usually consists of Brachiarra xantholeuea, Eragrostis tremula, Cenchrus biflorus, Aristida pallida, Andropogon gayanus, Pennsetum pedicellatum, Blepharis linariifolia Zornia glochidiata and Monechma hispidum. Currently Cenchrus biflorus (Huskaneit), Aristida pallida (Sermeima) [1].

In the study area there are two different types of plants in the two soil types. They were distinguished by Harrison and Jackson (1958) as two subdivisions of the low-rainfall savanna vegetation

belt, namely (1) low-rainfall forests in savannas on clay and (2) low-rainfall forests in savannas on sand [11].

Which should be noted here is that most of the oil fields in Sudan are located within the rich savannah with good vegetation, and this in turn creates great complications that make the oil industry have a clear impact on the reality of vegetation in oil production areas. Hence the need for such studies that are concerned with monitoring to monitor the reality of vegetation cover, modern technologies such as geographic information systems (GIS) and Remote Sensing (RS) technology are used to obtain the most accurate results.

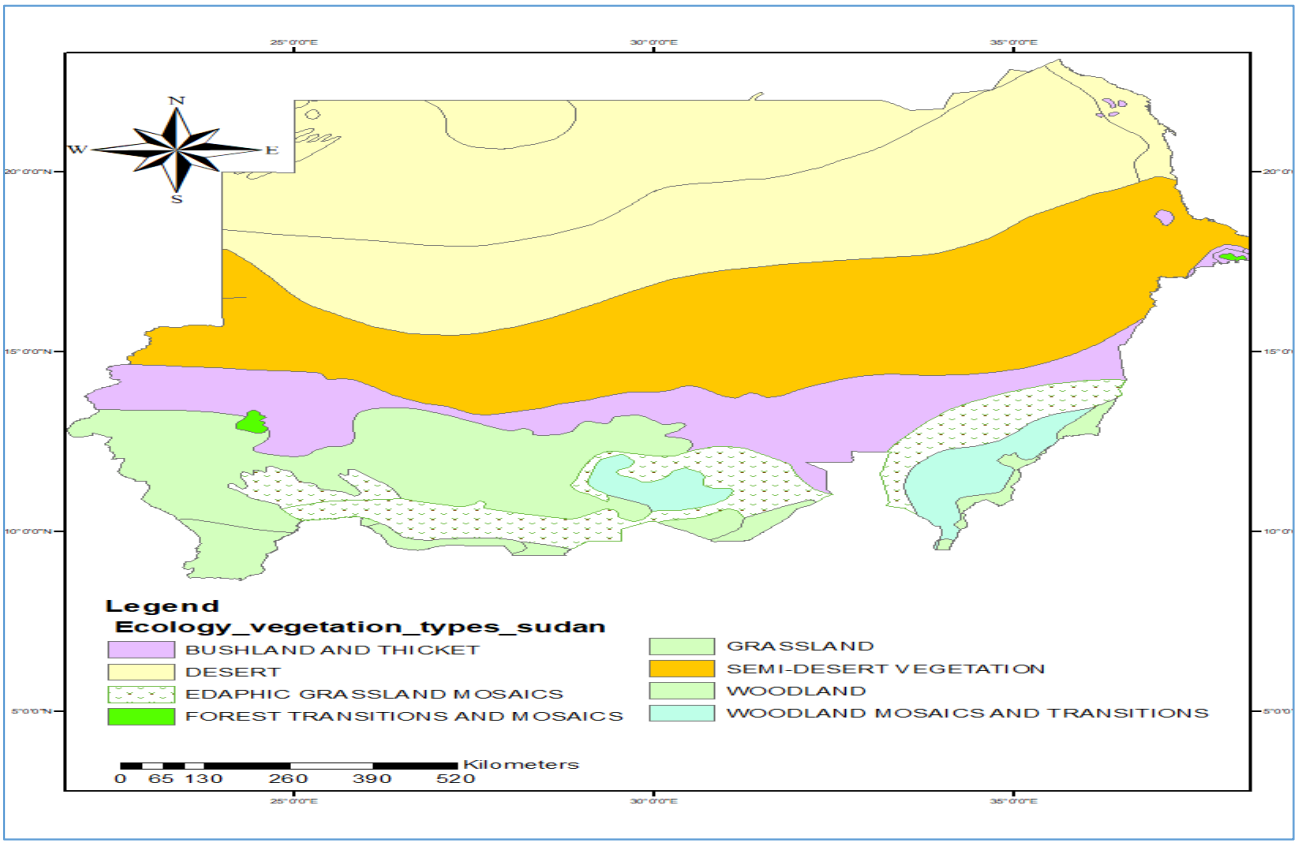

Figure 1. Ecology – Vegetation types in Sudan.
Source: FAO, 2020.

Martials & Methods

1. Study Area

The study area is located between latitudes 11° 20’0’ to 11° 40’0’0’’ N and longitudes 28° 10’0’’ to 28° 40’0’’ E. The area in general has a flat topography, with elevations ranging from 502 m to 690 m and a slope of 0 to 24 degrees. The area is dissected by many surface-water courses (khors and wadis) in a dendritic pattern. The general topography of the project site is gentle hilly land. The site elevation is about 509.05 to 511.1 m above sea level. The ground surface is covered with dense primeval forests and overgrown with grass and weeds among the forests [9].

The climate in the study area lies within the Sudan-Savanna belt, with an annual rainfall of 600–700 mm. Rainfall is confined to the months of June through October. The rainy season extends from May to October, with peak values in August and September when the Inter Tropical Convergence Zone (ITCZ) is in its extreme northern position. The period from November to April is dry [5].

This study included seven major oil fields in the oil-rich state of West Kordofan: Balila, Defra, Neem, Al-Jeck, Al-burasaya1, Al-burasaya2, and Al-Frdous. These seven fields contribute about 25,000 barrels per day, which constitutes more than 41% of Sudan’s current daily oil production [9].

2. Data Collection and analysis

The vegetation of the study area was evaluated to determine the impact of the oil industry satellite image analysis using the GIS and ERDAS programs. In addition, the study used secondary data and the field observation method.

Changes in vegetation (land cover) were also evaluated using Landsat 10 images for the years 1999, 2015, and 2023. These images were processed and classified into different types of land cover using GIS software. The study area was selected from the Earth Explorer website, and then a file of the study area was created. Images dated 1999, 2015, and 2023 (on the same day and month) were then uploaded for future analysis and classification.

RESULTS AND DISCUSSION

1. Satellite images analysis results

From Figures 2, 3 and 4, the state of the vegetation and the extent of its deterioration because of the expansion of the oil industry are clear. The degrees of risk in describing the state of the vegetation cover in the study area ranged from very high risk to medium risk and very low risk, according to satellite images. In satellite images for the year 1999, which is the period of exploration and the beginning of oil exploration in the region, we fund that the level of risk in describing the situation of deterioration in vegetation is mostly low to very low risk, as the region still has not witnessed an expansion in oil production yet. The vegetation around settlements and some oil fields is good. Satellite image for the year 2015, which is the period that witnessed the expansion of the oil industry in the region. The vegetation began to be clearly affected by exploration and excavation activities, the construction of roads, and accompanying facilities, and here the risk in the state of vegetation in the area ranged from most of it being of moderate to high risk, especially around the Al-Jeck and Al-burasaya1 settlements, which include the Al-Jeck and Al-burasaya1 fields. As for the satellite image for the year 2023, it clearly showed the extent of the high and very high risk that the situation of vegetation had reached, as the deterioration included areas that were not affected, as is the case in the Al-Hejearat settlement located in the south of the study area and the Neem settlement near the Neem oil field.

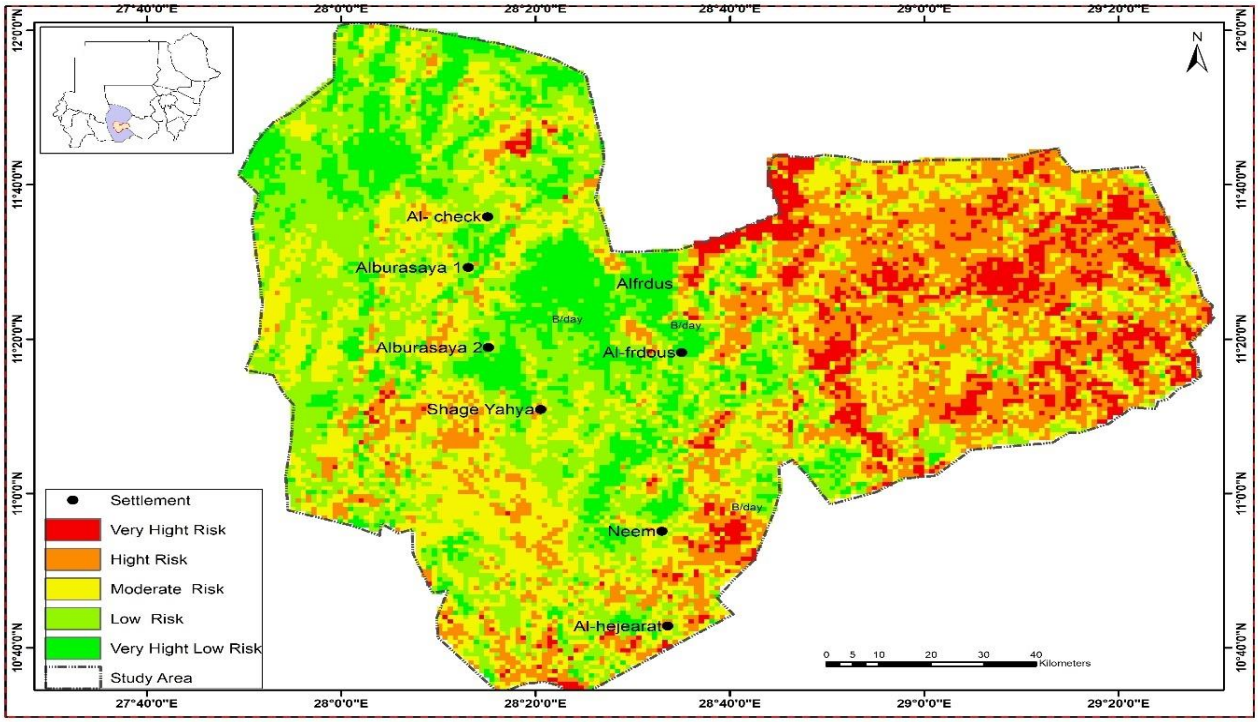

Figure 2. Vegetation cover 1999

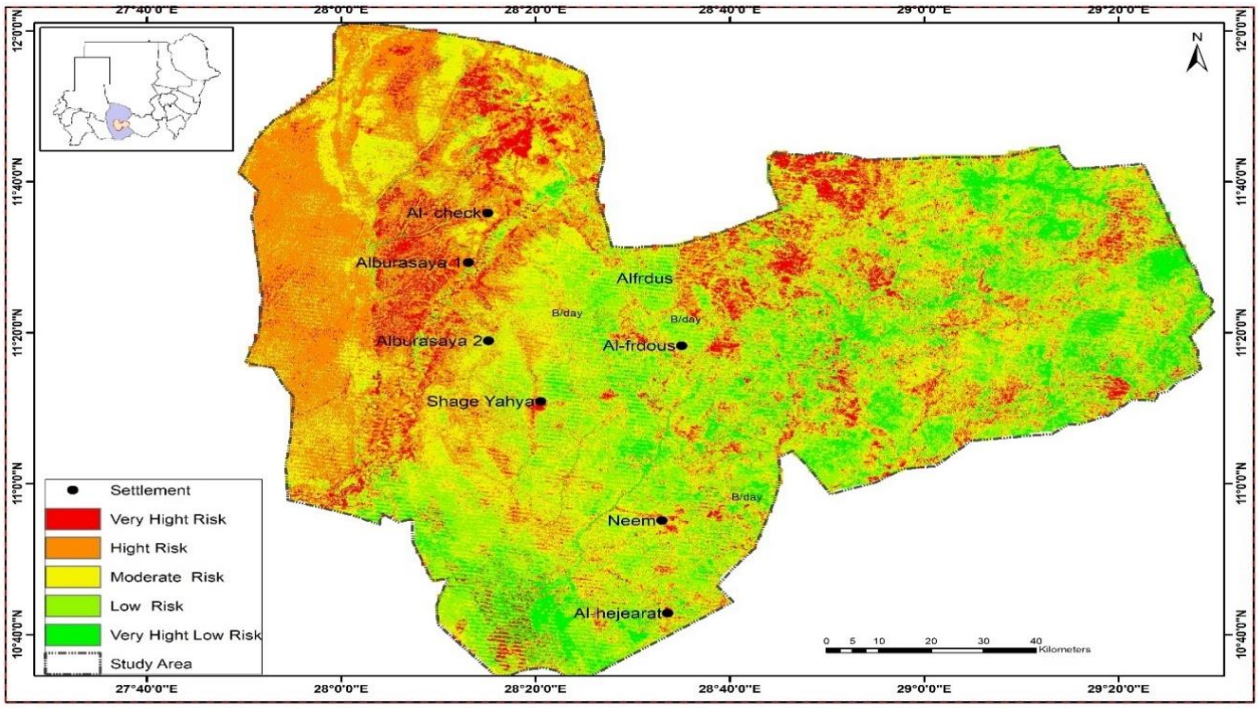

Figure 3. Vegetation cover 2015

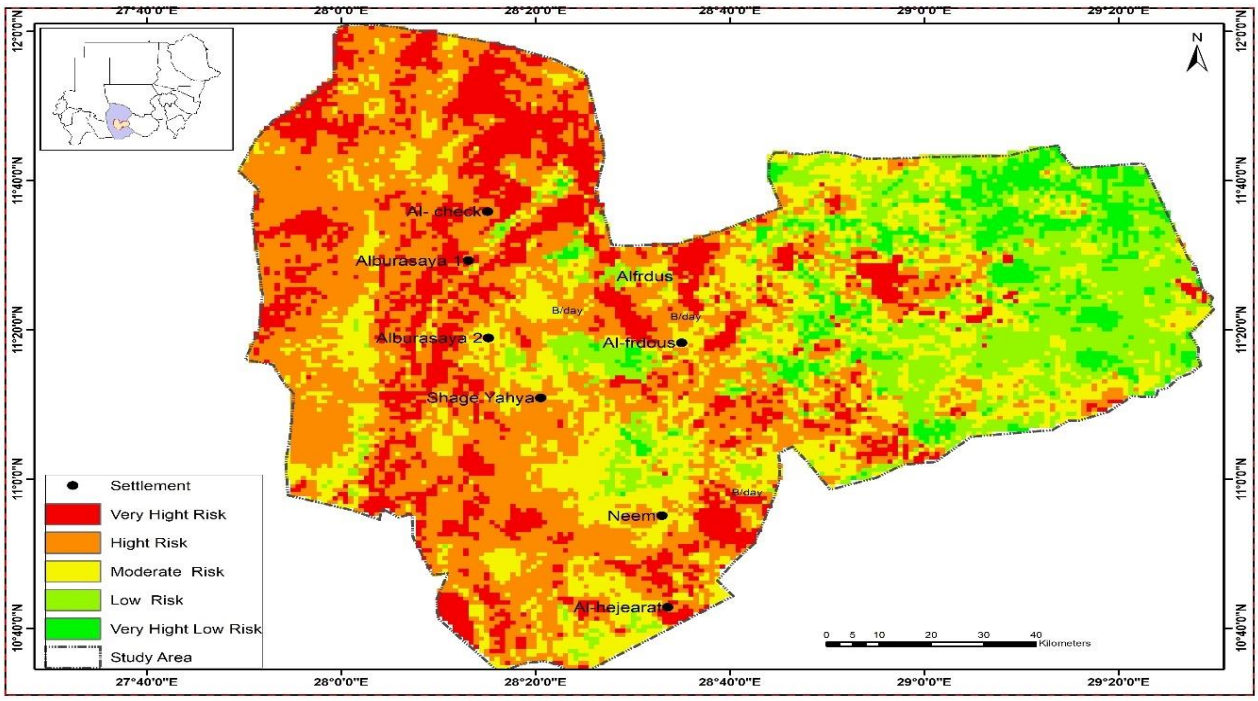

Figure 4. Vegetation cover 2023

Moreover, it increased deterioration to a very high risk in most of the affected areas, and this confirms that the recovery of vegetation in production areas is very slow or almost non-existent and may take a longer time.

The general observation is that the danger in the case of vegetation increases with the increase and expansion of oil industry activities in the study area and then reaches a critical state that cannot carry out the replacement process except with external interventions, and this was confirmed by both Gheorghe and Strat [4] and Mohamadi et al. [10].

2. Change in the percentage of vegetation cover compared to other land uses

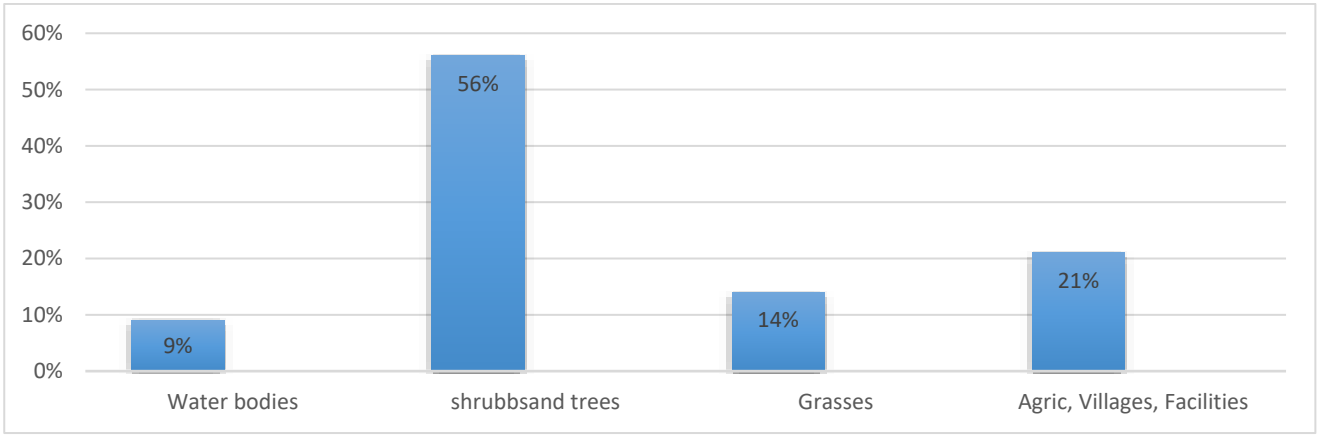

Figure 5. Vegetation percentage in 1999

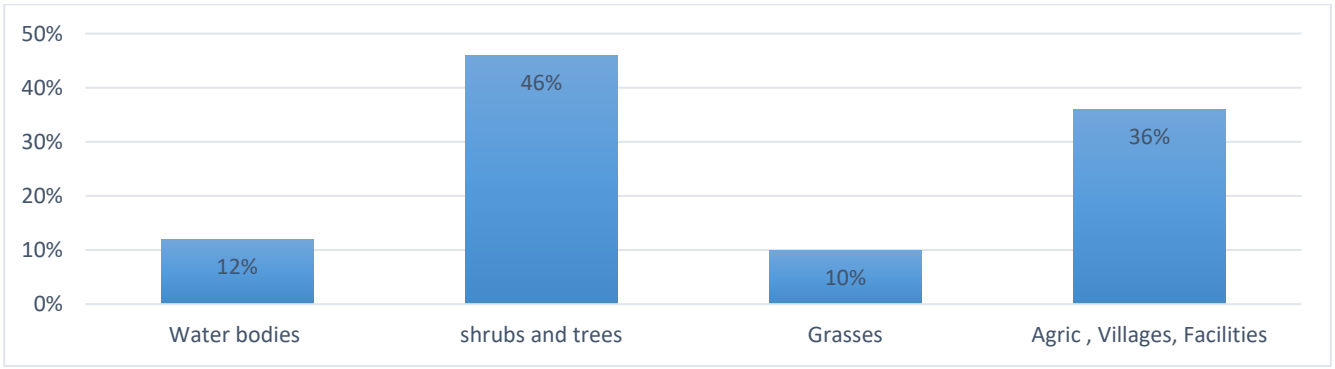

Figure 6. Vegetation percentage in 2015

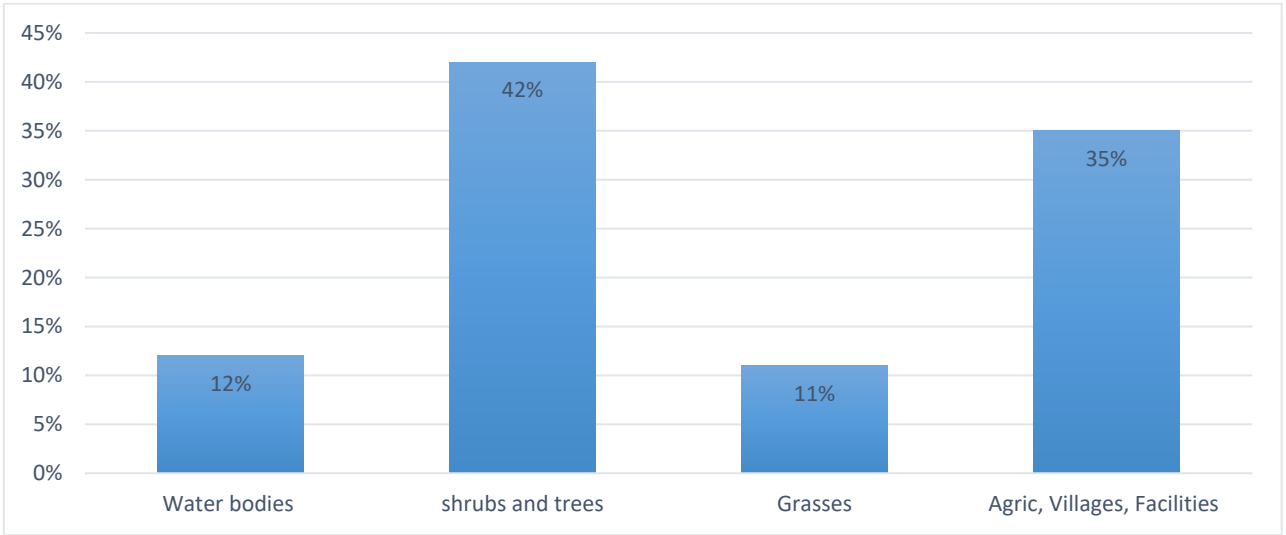

Figure 7. Vegetation percentage in 2023

From Figures 5 ,6 and 7, there is a clear decrease in shrubs and tree cover in general from 56% in 1999 during the exploration period and the beginning of the oil drilling period to 45% in 2015. This period has witnessed a noticeable expansion in the various oil industry activities. This requires removing an estimated amount of vegetation cover. The vegetation cover lost 10% of its previous

area, This is which Madani et al.[7] confirmed The period following exploration operations and increasing production is when the rate of removing the loss of vegetation cover in production areas is very high. The decline in the cover area continued until it reached 42% in 2023. This may also be a continuation of the expansion in the development of the oil industry through the entry of new wells into the production cycle in addition to the establishment of a road network to reach various oil facilities and others, and all of this may directly affect the area of vegetation in oil field areas was mentioned by both Mariano and Rovere [8] A. T. Bello and Nwaeke [3]. The general conclusion from analyzing satellite images and calculating the percentage of vegetation cover compared to other land uses is that the decline in the percentage of vegetation cover in oil field areas is offset by a noticeable increase in other percentages, especially in facilities and settlements, which indicates the difficulty of recovering vegetation cover in the study area.

Conclusion

This study examined the impact of the oil industry on vegetation in oil field areas in West Kordofan State in Sudan. The results showed that the development of the oil industry over the past years clearly contributed to the decline in vegetation, and its percentage declined from 56% in 1999 to 42% in 2023 out of total other land uses in the study area. The results of this study were consistent with the results of other studies that investigated the same direction.

The study believes that one of the ways to address the impact of the oil industry on vegetation cover is to pay attention to environmental impact assessment studies and continuous monitoring of the state of vegetation cover in the region, in addition to implementing reforestation operations to compensate for the loss of vegetation cover.

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