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# LANDUSE IMPACT ON ENVIRONMENT OF TUTI ISLAND, SUDAN

**ABSTRACT.** Environmental study was carried out to describe a geographical area and its biodiversity. The example here shows the features of human nutrition habits and quality of life with specific study of negative impact on the environment and Earth resources. Tuti Island in Sudan was prone to this complex problem so it is taken as a case study. The hypothesis is that the use of RS and GIS could help in reconstruction of unused territories so it could help to solve the problem. Changes of land use and land cover were observed using classified Landsat 5 images in 1972, Landsat 7 in 1985 and Landsat 8 in 2018. The results showed that several temporal changes occurred beside turning dense tree cover land into lands with other landuse purposes for 1972, 1985 and 2018. Agricultural zones (crops and trees) were major dominant zones in 1972, 1985 and 2018. In addition, populated residential areas increased through time but not as significantly as trees, sand and cropping landuse areas ( $P=0.89082$ ) as for the classified Landsat 8 image acquired in 2018. Ecosystem planning through GIS and RS could be a good way to solve most of these issues for the future of Tuti Island landuse.

**KEY WORDS:** Ecology, Sudan Islands, Landcover, Agricultural use

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## INTRODUCTION

The present and future global environmental challenges bother many world nations, for example the loss of biodiversity, the depletion of the ozone layer, climate change and global warming. In addition, water and soil contamination and food insecurity are the threats for human health in many countries. These problems are multiplied through history and became worse with population increasing. Increased world population affect the Earth resources directly and indirectly. Sudan is one of the most environmentally degraded countries in

the world. Natural resources in Sudan were severely affected by climate change and human interaction. Desertification as an outcome of natural resources degradation and environmental problems was observed through history of the country. Objective of the study is to solve this problem through study of Tuti Island environmental profile. This could give a sustainable solution for its environmental problems and provide food to it is population in a sustainable manner.

## Environmental degradation in Sudan

Eltoum et al. (2015) studied the role of several ecological factors in causing

desertification in Sudan. Eltoum (2017) monitor the state of ecological zones in Sudan since 1958 to 2017 and reported several changes in the country eco zones. Recent researches provide evidence that most of its land was covered by desert and semi-desert zones resulting from severe drought and deforestation (Eltoum et al. 2015; Eltoum 2017). The water resources degraded both qualitatively and quantitatively. The biodiversity decreased due to habitat destruction and weak environmental awareness not only among the public but also among the policy makers (UNEP 2007). Tuti Island is a case of fragile eco system in Sudan where erosion, floods, and landuse conflicts take place. Many researchers take Tuti Island as study area from several perspectives as Lobban (1982) studied the class and kinship of Sudanese urban communities based on Tuti community compared to Burri al Mahas and other Khartoum communities to investigate the effect of urbanization in the Sudan. Although Tuti Island was reported as an isolated area, some changes were observed by researchers latter on. Khidir (1998) reported some social changes between rural and urban communities and divided the life on the island into old village area and new urban one. As researches show, the environment of Tuti Island also changed through history as a response to many factors including human activity and climate changes (Osman 2004; Mohammed 2007; Salah and Idris 2013).

### Geography of Tuti Island

Tuti Island is one of Sudan islands which located in the joint point of the White and blue Nile in Khartoum state at N15.37 E32.29. The three main cities which form Khartoum state are Khartoum, Khartoum North and Omdurman. Tuti Island is located at the central point of these cities. It believed that it was the first populated area in Khartoum region and it may have been established before the 15<sup>th</sup> century during spread of Islam (Osman 2004). Although signs of Arabic language may have presented earlier than 15<sup>th</sup> century in this region (Aldarier 1922). Archaeological studies mentioned that most of Sudan

islands were inhabited by ancient populations which may belong to old Nubian civilization. During Soba kingdom before 15<sup>th</sup> century Tuti island was very famous but there is an information only about one church. Most of the population have appeared after the migration of Arab and Islamic tribe to the Island. Since that time the Island has been isolated from the three cities for many years. In 2009 Tuti bridge was constructed and it linked the island with Khartoum city. Hence, the modern style of life was transferred. Additional two bridges have been suggested by Khartoum Structure Plan to link Tuti Island with Khartoum North and Omdurman cities. The soil of Tuti Island formed from three components which are Nubian sandstones, basement complex, and Rivers deposits which include Sandy soil, Clay soil and Rivers mud, more detailed info could be found in researches of Mohammed (2007).

### Environmental setup

Harison and Jakson (1958) describe Khartoum state as Semi desert area. Later Eltoum (2017) recorded turning Khartoum state into desert. Climate change and desertification were the main reasons of its environmental change. Although Tuti island is isolated by the three rivers (Blue Nile, White Nile and Nile rivers), the climate conditions are described as arid with low rainfall and high evaporation. Accordingly, some changes have occurred in it. Flood disaster was regularly recorded in 1964, 1977 and 1988. Water erosion (Haddam) affects most of its agricultural areas on the rivers sides banks of the Tuti Island. Creeping sand from different parts of the country form seasonal wadies settled in the South part of the island. Population of Tuti Island increased thrice from 5851 in the years 1955/1956 up to 14400 in 1999 with the rate of 10 thousand each 45 years. The continuous increase in the population enhanced amount of waste which directly affected water quality in the river Nile. Animals have been raised for domestic use (meat and milk) while in the past cows had been used for soil cultivation. Group of hunters use many strains of dogs,

specifically the merowe dog and saluki dog strains were found in Tuti Island. Tuti Island is a dense vegetated area in Khartoum state with a high diversity of plants composition. Availability of water from rivers, Nile, Blue Nile and White Nile in addition to clay soil support the vegetation diversity.

### Landuse and Landcover

Bahreldin and Eisa (2014) divided Tuti Island into three zones: old Tuti, central Tuti and farm land. Old Tuti looks like group of small Sudan villages while the central zone has different style. Khartoum Structure Plan in 2014 planned 14 zones for future use of Tuti Island. Since the island is considered as special zone, environmental planning must be taken into account. Historical reports from Islamic civilization have mentioned that Tuti Island and Khartoum city had been forest areas before human beings settled in it. Recently both areas have been used as residential areas beside farms land. While forest areas protection exists in Khartoum city, deforestation on Tuti Island has occurred. Gradual change in land use of both areas has been observed. Many researchers attribute this change to increased population in both areas and settlement activities (Mohammed 2007; Salah and Idris 2013; Bahereldin and Eisa 2014). Agricultural activities on Tuti Island were historically reported since farms have covered most of the area. Several agricultural crops were planted including

vegetables, fruits, citrus and forages (Mohammed 2007).

### MATERIALS AND METHODS

Satellite images were downloaded from USGS web site. These images include recent Aster Dem images for the year 2018; Landsat images for the different periods of time; Landsat 8 which was acquired in 2018; Landsat 7 for 1985 and Landsat 5 for 1972. The images were added to Sudan geo database map which was collected from the Internet. Study area was observed through Google Earth (Fig. 1). To visualize the eco zone component remote sensing and GIS techniques were used, in particular the method of Image supervised classification. The landcover was classified and landuse was identified by using visual interpretation of classified Landsat 5, 7, 8 images and Google earth images. Overlaying techniques were used to identify these classes.

### RESULTS AND DISCUSSION

#### Landcover and landuse map

The landcover and landuse map terms were used generally to describe the geographical patterns of specific area. The new technology which appeared on this century with the use of computers and its software applications provided fast, easy and low cost method to describe these patterns. The geographical information

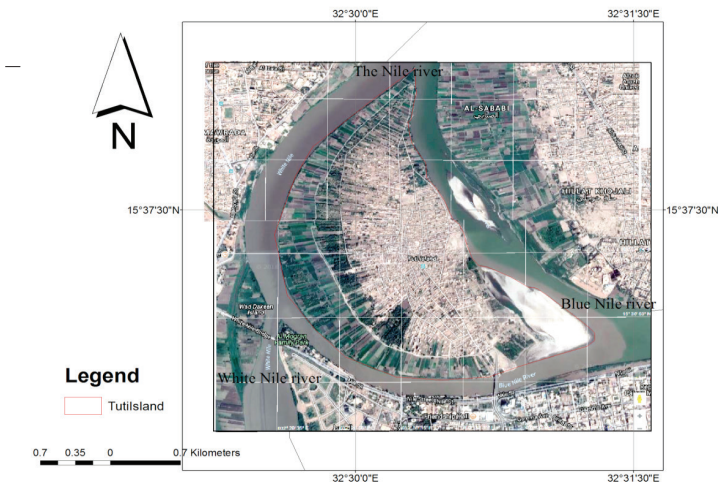


Fig. 1. Tuti Island surrounded by rivers and urban areas of Khartoum state

system and remote sensing stand in front of many branches of science which benefit from them. Supervised classification method in GIS and RS was used to describe the land cover and create landuse map. Fig. 2 shows the land cover classes of Tuti Island in 1972. There were three main classes present in 1972: vegetation, residential area and sand. Most of the Island was covered by vegetation which could be classified as dense and low.

As population increased residential area enlarged and agricultural areas substituted the natural vegetated areas. The sand masses travelled by river water to other location. Fig. 3 represent the change in land use form 1985 to 2018. The residential area has expanded to replace vegetation in some location on the north and west part of the island. The border of the island was reshaped and extended to the south due to sand settlement and water erosion. An increased water area surrounding the island was observed. Increase in some vegetated areas may refer to agricultural activity and shift from trees to low vegetation. A decrease of the Island land in the South part was due to water erosion of the Blue Nile River. The results of classified images in 2018 showed that low vegetated areas were used as agricultural areas for cultivation of crops mainly vegetables and

forages on silt and clay soils. These soils have mainly been formed by the residue of flood which occurred due to the rivers mud moving during floods periods. These fertile soils represent a good base for diverse vegetation through history as it was mentioned (Mohammed 2007).

The high biomass vegetated areas were covered by trees which are fruit and citrus plants with few scattered trees. The soil covered by residential areas was used for settlement of Tuti island population through historical period (Fig. 4). These results are full agreed with spatial classification results (Bahreldin and Eisa 2014) on Tuti Island in addition to the flora of Tuti Island which was classified by Mohammed (2007). The shift and replacement of natural forest trees biomass layer with cultivated citrus and fruit trees may reflect the human activity in this eco system. This may lead to clearance of other forest layers mainly shrubs and grass. This process exposed the soil to water erosion and decreased the land area specifically on the river Nile coast where extensive agricultural practices exist. In general, the land cover present on Tuti Island could be divided into vegetated area including trees area beside cultivated area, water area (Nile, white Nile and blue Nile rivers), residential area and bare area. Landcover

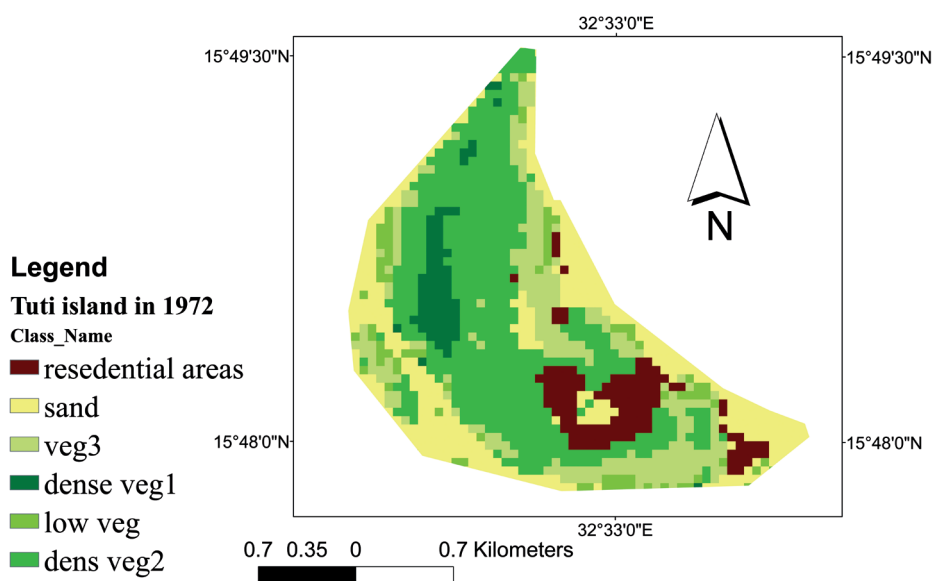
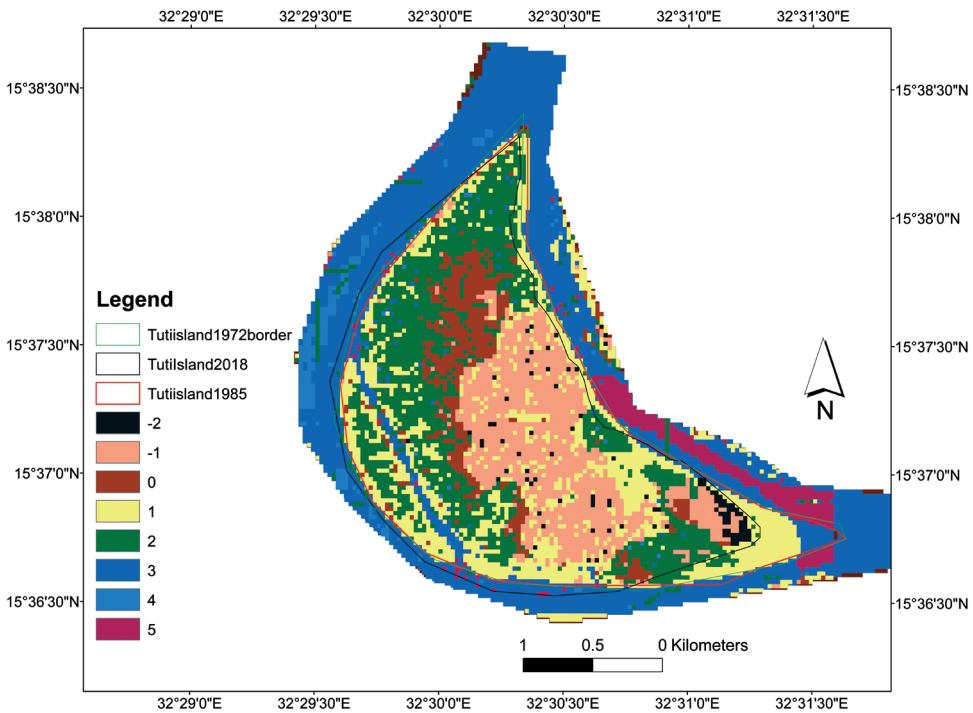


Fig. 2. Land cover classes of Tuti Island in 1972



**Fig. 3. Change of landuse on Tuti Island during 1985-2018**

and landuse of Tuti Island create a critical question about the past formation of this island. Could the island be a part of the Gazera area in the middle of Sudan or stand as an old Delta of the White Nile River which was converted to an island later on due to change in the water course and path way of the Blue Nile river? Further study and investigation may be needed to clarify these assumptions. This may give an opportunity to understand the past environmental system which was present on the island during the past century. Critical investigation of this information will help researchers to plan for sustainable use of this zone.

Landuse classes are occupied with different parts from the total area of Tuti Island (Fig. 5). The high percentage dominant class is crops which represents more than 50% of the total Tuti Island area followed by residential areas which represents 30%. Trees represent only 6% of the total area which is alarming. This means that the area is almost free of trees. Mahmoud et al. (2016) considered Um Dom Island not far from this area in Blue Nile and found that

the forest plant species differ and the tree layer was dominated by acacia and other species. Salah and Idris (2013) reported that environmental state of Alsunut forest in Khartoum city and Tuti Island is controlled by the rivers and human influences. Creeping sands which settled on the river cost on the southern part of the Tuti Island represent an area about 4%. The minimum areas were occupied by wet soil with water from White and Blue Nile rivers - 1% for each area.

### Environmental planning of Tuti Island

In environmental planning for sustainable life on Tuti Island the farms, farmers and farm owners must be involved in any plans for reconstruction of Tuti Island because they represent the major group of the island in 2018. Insignificant difference between the residential areas and other groups (agricultural crops areas, trees and sand) indicate a well-balanced use of land for settlement purpose. Nevertheless, a priority must be given to an incoming generation in the future from the same indigenous population to conserve this

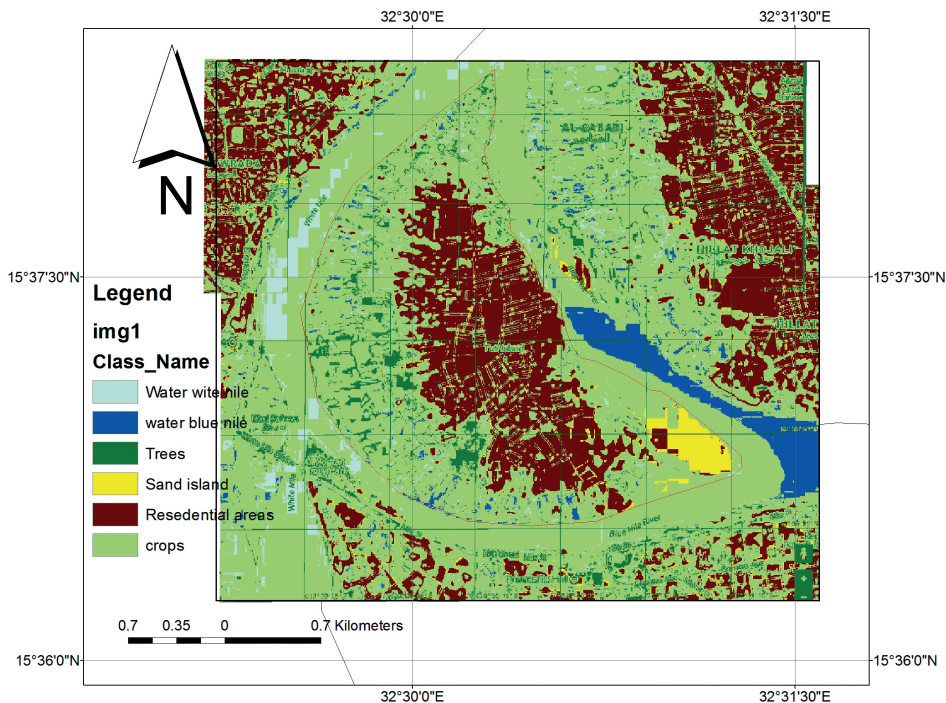


Fig. 4. Landcover and landuse classes of Tuti Island in 2018

balance. The prevention of swamp soil area appearing and increasing trees cover will add more environmental values to these areas as in Alsunut forest zone in Khartoum city. These facts agreed with findings of Osman (2004) who reported that there is a high need of principle guide line for sustainable future planning of Tuti Island.

CONCLUSIONANDRECOMMENDATIONS

In conclusion, Tuti Island was under sever changes due to climate change, desertification, flood disasters and human impact. From 1972 to 2018 the island witnessed several environmental changes and shifts. Temporal increase of human being activity may have adverse impact on

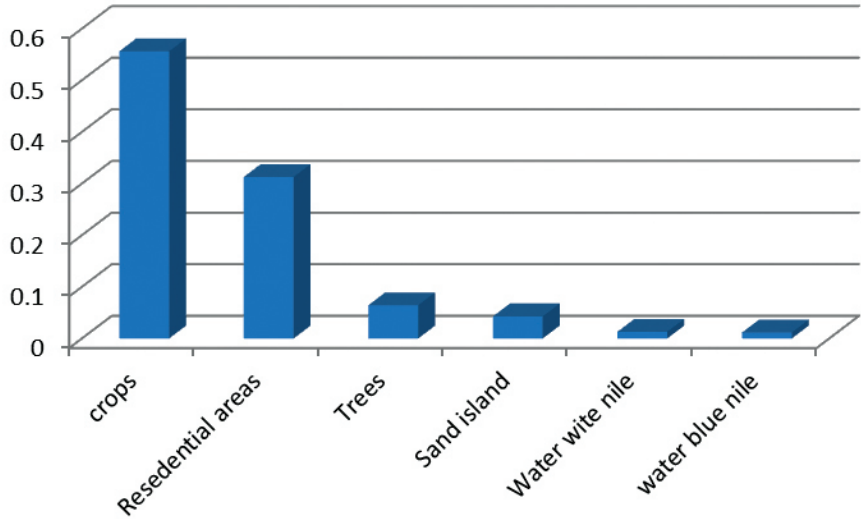


Fig. 5. Percentage of the landcover classes from the Tuti Island total area

the environment. Corrective measures must be taken to minimize these changes to serve the need of its residents without damaging the islands environment. Environmental study could help in implementing planning approach to conserve this unique biodiversity area. Environmental degradation are present in several parts of the Earth globe. Increasing population, climate change and urbanization have enlarged the geographical areas where

several environmental systems have crashed. It's clear that corrective measures must take place in these environmental systems for sustainability of live in it. Human beings have played an important role in the environmental systems degradation so changing their behaviour to more positive impact is highly needed. Replanning, organizing and leading of the affected population maybe the first step in achieving sustainability goals. ■

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