Ecological Implication of Habitat Fragmentation and Introduction of Alien Species on Biodiversity Condition in Ikogosi Environs, Southwestern Nigeria

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Abstract:- **The impact of landscape fragmentation and exotic species introduction to the Ikogosi environs was assessed through the rate of deforestation, habitat degradation and displacement of indigenous species in the community. The study aims to enquire the state of biodiversity condition and alien species introduction. In all, 264 copies of questionnaire were successfully retrieved from the respondents and were subjected to statistical analysis. Furthermore, geospatial technique was employed to evaluate the modification done to the forested area in the study area. The 30 meter Landsat image of TM 1991, ETH+ 2002 and OLI 2015 were digitally processed using ArcMap 10.3 while Fragstat 4.0 was employed to complete the fragmentation analysis for the study. The findings revealed that the Number of Patches (NP) increased by 257, 268 and 281 while Shannon Diversity Index (SHIDI) correspondingly decreased by 0.54, 0.47 and 0.21 for species diversity in the year 1991, 2002 and 2015 respectively; indigenous respondents (70.1%) affirmed the extinction of biodiversity. In addition, respondent listed a host of plants and animals that had gone extinct, and these include: antelope, bat, monkey, squirrel, cassia and waterleaf. Respondents (76.1%) affirmed that exotic flowers have replaced indigenous species. The study concluded that anthropogenic activities had bastardized the natural ecosystem, increased deforestation and degrade the forest resources; hence, triggered wildlife disturbance. The study recommends ecotourism and restriction of human encroachment to avoid poaching.**

Keywords**: *B*iodiversity; *E*cosystem; *E*nvironment and *H*abitat *F*ragmentation**

I INTRODUCTION

Deforestation plays an important role in habitat fragmentation which has been regarded as threat to the maintenance of biodiversity (Adriaens et al., 2006). Thomas et al. (2004) reported that habitat fragmentation resulted from changes in the arrangement of the remnant forest leading to the loss of ecosystem community; and these spatial changes affect the biological population as well as ecological process that may aggravate the ecosystem imbalance. Tilman et al. (2001); Thomas et al. (2004) suggested that anthropogenic activities have been the primary cause of biodiversity loss on a global scale; this is accelerated by the invasion of alien species and overexploitation of forest resources due to population growth and climate change (Thomas et al., 2004; Brook et al., 2008; Morris et al., 2008) As Krauss et al. (2003) further states that species taken from foreign habitat and introduced into local habitat often end-up eradicating native species that were present before invasive species were introduced. However, this condition may happen to many other native species living in different habitats at a global scale.

Correspondingly, studies have revealed that carbon stock reduction and consequential effects on climate change is a functional of high rate of deforestation (Jackson and Sax, 2010); in addition, studies have reported evidence of rainfall irregularities and global rise in temperature due to high rate of deforestation (Helm et al. 2006; Cousins, 2009). Furthermore, various studies have revealed land cover modification such as urbanization, agriculture and transportation infrastructures which are generally recognized as subset of human factor contributing to biodiversity loss (Cremene et al., 2005). Urbanization for instance affects land cover through the transfiguration of rural-urban connection (Hahs et al., 2009). Burnham and Anderson (2002) posited that luxurious lifestyle of urban populaces have tried to capture the effects on changing land use pattern thus affecting the rapid response on vegetation loss especially in area of natural resort attraction where social amenities facilities supports the tourism potentials and business (Johnson and Omland, 2004). In the same vain, Orimogunje (2010) found that timber harvest accelerates the rate of forest resource loss, extinctions, and ecosystem imbalances. In addition, poaching and wildfire contributed immensely to the rate of b diversity loss as local people engage in bush burning (Sala et al., 2000). Although, limited studies have revealed the importance of eco-tourism and how it has benefitted biological productivity and conservation while less attention is given to rising environmental problems (Lindenmayer et al., 2008).

Therefore, associated ecological impact of deforestation and exotic species invasion pose a threat to biodiversity and ecosystem services through the changes of

land use pattern (Haps et al., 2009); this is driven by global population growth, pressures on food security as well as lifestyle have been some of the primary drivers to ecosystem degradation This study aimed at assessing the ecological implication of fragmentation activities and introduced alien species in-around Ikogosi environs. The study takes into account the magnitude of fragmentation done through anthropogenic activities to the local ecosystem; assess the rate of biodiversity loss in the study area and evaluate the impact of exotic flower species on indigenous plants in-around the ambient of the Warm Spring Resort Centre. This is with the view of revealing the height of disturbance done to the indigenous species, habitat loss and rate of biodiversity extinction.

1.2 The Study Area: Ikogosi Warm Spring Centre

Ikogosi Ekiti in Ekiti State, Nigeria (Fig. 1) lies between Latitude 7^{o} 35' N and 7^{o} 34' N, Longitude 4^{o} 58' E and 4^{o} 59' E and the elevation ranges from 457.0 - 487.5 m above sea level (Olorunfemi and Raheem, 2008). Ikogosi Ekiti, the study area was selected based on her natural warm and cold springs which attract visitors to the tourist center for vacation, conference and educational research. Ikogosi Ekiti is located in the tropical rainforest and is characterized by a nearly uniform high temperature throughout the year with an annual mean temperature ranging between 21° C and 28° C with high humidity (Ojo et al., 2011; Hairul et al., 2013). The natural vegetation of the area is characterized by emergent forest with canopy layers and vines around the undulating terrain of the rocky region in Ikogosi. Also, Ikogosi Ekiti is a rural center with limited settlement, homogeneity in nature and total population of 3,594 (National Population Commission, 2006). Local populace engaged in primary occupation like farming, fishing, crafting, among others.

National Bureau of Statistics (2016) reported that numerous tourists visit the place to enjoy the luxurious warm and cold swimming spring with the accompanying leisure provided for recreational needs. Ikogosi is also the home of the 5-star chalets rooms and Gossy Water Bottling Industry; a subsidiary of United Africa Company, Nigeria. This has transformed Ikogosi to a renowned world class tourist center with average annual visitors numbering over a million (NBS, 2016). The large number of visitors to this region has increased demand on natural resources and increased the strain on local biodiversity.

II. MATERIALS AND METHODS

This study made used of remotely sensed data, questionnaire administrative and sample collection of plants species for proper identification. This was done to assess the changes in the biomass condition of the study area at the period of year available using geospatial data. Practically, a field investigation was conducted alongside questionnaire administration so as to augment the obtainable result from geospatial analysis

2.1 Data sources

Satellite imageries of Ikogosi were acquired from Global Land Cover Facility (GLCF) on Earth Science Data Interface (http://glcf.umaiacs.umd.edu). The 30 meter Landsat images of Thematic Mapper (TM), Enhanced Thematic (ETM+) and Operational Land Imager (OLI) of 1991, 2002 and 2015 (both path / row 190 / 055); covering the study area was acquired. The images were geometrically corrected to Universal Transverse Mercator (UTM) coordinate system. Also, the ground-truth information required for the classification and accuracy assessment of the Landsat images was collected through a field survey which was carried out between December, 2016 and January, 2017 using Global Positioning System (GPS). In addition, purposive sampling method was used to select 200 respondents of the Ikogosi community who are 15 years and above. Accidental and availability sampling method was also used to select 50 tourists from the Ikogosi Warm Resort Centre (IKWRC) and random sampling method was then employed to select 20 respondents who are staff of IKWRC. A total of 270 copies of questionnaire were administered while 264 copies of questionnaire were successfully retrieved from the respondents and were analyzed for the study. Chi-square statistical test was employed to analyze the data. Besides, an open list was also provided for the respondents to enlist names of animals and plants that were no longer observed in Ikogosi community. In addition, samples of exotic ornamental flowers observed in-around the Tourist Centre were harvested and taken for identification at the Institute of Parks and Garden, Obafemi Awolowo University, Ile-Ife, Nigeria.

2.2 Digital Image Processing

The satellite images were processed using ArcMap 10.3 software and exported to Fragstat 4.0 for habitat fragmentation processing and analysis. Pre-processing operations in form of linear contrast stretch and spatial filtering were performed on the Landsat images which were also geo-rectified to Universal Transverse Medicator (UTM) projection system and datum defined as WGS-84. The classified imageries were analyzed to create Patch Analyst; five landscape levels metric were developed for the class metric to quantify for spatio-temporal changes in Ikogosi landscape composition and configuration among the classified imageries. These include Number of Patches, Patches Density, Largest Patches Index, Shannon's Diversity Index and Simpson's Diversity Index. The patch size stratification of the study area was considered as a primary criterion to assess the fragmentation and in order to estimate the level of isolation of the forest fragmentation; patches were categorized under five classes: i.e. Lowest (<25 ha), Low (25-50 ha), Moderate (50-100 ha), High (100 - 200 ha) and Highest (>200 ha). Each index indicates one aspect of fragmentation; the number of patches might indicate that it suffers a higher rate of

deforestation. The class metric was designed to reveal the rate of biodiversity as a result of fragmentation done to the diversity of vegetation measured at the periods considered.

III. RESULTS AND DISCUSSION

3.1 Habitat Fragmentation and Impact on Biodiversity Loss

The findings revealed the rate of biodiversity loss as a result of habitat fragmentation in the study area. Table 1 showed that Number of Patches (257, 268 and 281) and Patches Density (16.09, 22.78 and 29.01) and Largest Patches Density (16.09, 22.78 and 29.01) increase in the years 1991, 2002 and 2015 respectively. This increase in the level of fragmentation in Ikogosi was due to developmental changes which include construction of buildings, road network and abandoned farmland contributing to the increase in the number of isolated patches observed in the study area between the years 1991-2015. This connotes a response to socio-economic factor that forced villagers into activities like farming, deforestation, lumbering and construction activities in-around the Warm Spring Resort Centre and the entire of Ikogosi community; indicting some element of habitat fragmentation pattern in the entire study area. Adetoro et al., (2018) stated that habitat fragmentation invariably involves some amount of habitat destruction of plants and other sessile organism in the area while mobile animal retreat into the remnant patches of habitat.

Orimogunje (2010) affirmed that these actions therefore lead to crowdedness effect and increased competition in the remnant habitat. Figures 2, 3 and 5 showed the magnitude of fragmentation activities ranging from lowest to the highest; these levels of fragmentation measured in the Ikogosi community accounted for a rise in the complex assemblage of habitat. Besides, Shannon-Wiener Index (0.54; 0.47 and 0.37) and Simpson Diversity Index (0.38; 0.29 and 0.21) showed a decrease in the species diversity for the year 1991, 2002 and 2015 respectively. The findings imply a gradual decrease in species diversity and evenness as engineered by incessant disturbance to the ecosystem. Similarly, Simpson Diversity Index (SIDI) showed a decrease in the species diversity as values were 0.38, 0.29 and 0.21 for the year 1991, 2002 and 2015 respectively. Regarding the biodiversity loss as noted by Olukoi et al. (2011) that the replacement of forest by man-made features have negative effects on the species richness in any ecosystem. Consequential impact revealed that fragmented habitats tend to host limited number fauna and flora species leaving the corridor of the fragmented habitat with rare species and animals migrating away into the core of the remnant secondary forest.

3.2 Surveyed Perception of Biodiversity Loss in Ikogosi Community

Table 2 gives a summary of a surveyed respondents' on the impact the tourism activities and the trend of biodiversity loss in the study area. The findings revealed that deforestation (72.0%); agriculture (62.1%); exotic species (76.1%); poaching (70.1%) and illegal logging (70.5%) accounted for high rate of biodiversity loss in the study area. The rate of forest degradation is high and worrisome; in all the questionnaire data analysed, calculated values varied significantly ($T_{(0.01)}$ =13.82; $p < 0.01$) at level of 99% confidence level. The manifestations of these have been noted to be in form of the rapid disappearance of forest cover leading to loss of biodiversity, soil degradation and unfavorable climatic changes. In a related studies by Helm (2006); Cousins (2009); biodiversity loss is attributed to anthropogenic pressure owing to continuous expansion of built-up areas which could have serious implications on hydrology, microclimatology and soil health.

Displayed Equation 1:……

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

3.3 Respondents' Open List of Observed Biodiversity Loss and Exotic lowers

The study also took into consideration the respondents'' view on the trend of biodiversity loss and introduction of exotic species in Ikogosi environment with specific reference to the changes observed in-around the Ikogosi Warm Spring Resort Centre. The open list provided in the questionnaire shown list of plants and animals that have ceased to be seen in-around Ikogosi community. The older generation (respondents above 40years of age) were majorly the key factor in providing information on the trend of biodiversity loss. The respondents listed some of the animals that were longer found around the Ikogosi community which include antelope, monkey, bat, squirrel and others (seeTable3). The absence of certain animals like Antelope (*Antilocapra americana),* Bat (*Tadarida spp*), squirrel (*Sciurus aberti*), African Forest Elephant (Loxodonta cyclotis) and plants: Chocolate cosmos (*Cosmos atrosanguineus*), Cassia (*Cassia sieberiana*) and Mahogany *(Swietenia mahagoni)* to mention a few are indicators of deforestation because these animals are associated with tall canopy-like tree as they jump around them in their habitat. Also, there has been replacement of indigene species with ornamental plants to beautify the outer surrounding of the Warm Spring Resort Centre. Reasonably some numbers of exotic plants were attested by the respondents to have grown in-around the tourist centre showing that indigenous plants have been partially removed to create space for invasive species. The present rate of biodiversity reduction and increased exotic species are capable of creating ecosystem imbalance thus reducing the diversity richness (Hoekstra *et al.,* 2005).

Loss of biodiversity is also attributed to peasant farmers that use wildfire to prepare land for pre-planting operation and hunting for bush meat as noted by Haddad et

al., (2009). This is related to the socio-economic income of the Ikogosi community which is generally low; hence, pressure is on the logs and wood from the forest for domestic uses and income generation

IV. CONCLUSION AND RECOMMENDATION

The study used satellite based technology in capturing spatio-temporal data; this was augmented with questionnaires administration in achieving information on habitat fragmentation, biodiversity degradation and alien species invasion in the study area. The study concluded that uncultured anthropogenic activities in Ikogosi Ekiti; especially in-around Ikogosi Warm Spring Resort has created ecological problems to the immediate local community in terms of increased deforestation, species extinction, ecosystem destruction, habitat fragmentation and bush burning. The quest for facilities and infrastructural development especially by tourism developers had led to various alternations in the natural forest coverage and patterns of secondary forest regrowth is under serious threat. By implication, forest resources have been significantly threatened and vegetation lost in on the increase. Similarly, beautifying the Ikogosi Warm Spring Centre has led to displacement of many indigenous plants due to introduction of exotic ornamental flowers which are capable of threatening native plants thereby limiting the diversity robustness of the study area (Dennis et al., 2003).

The study recommends that Ikogosi has high potential for ecotourism. There should be community-based ecotourism development with the aim of achieving sustainable conservation of the forested land. Besides, there is need to discourage deforestation and fuel wood consumption in the host community.

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Table 1: Landscape Metric of Fragmentation Levels in Ikogosi Community

Years	NP	PD	LPI	SHIDI	SIDI
1991	257	14726	16.09	0.54	0.38
2002	268	16809	22.78	0.47	0.29
2015	281	19002	29.01	0.37	0.21

Note: NP = Number of Patches
PD = Patches Density
LPI = Largest Patch Index
SHIDI = Shannon Diversity Index
SIDI = Simpson Diversity Index

Table 2: Respondents` Perception on Impact of Tourism as a Contributor to Biodiversity Loss

Element	Agree (%)	Disagree (%)	No Idea (%)	Cal-value	T-value
Deforestation and erection works	190(72.0)	70(26.5)	04(1.5)	66.83	13.82
Agriculture and habitat loss	164(62.1)	93(35.2)	07(2.7)	104.63	13.82
Exotic species for beautification	201(76.1)	60(22.7)	03(1.1)	53.79	13.82
Poaching and wildfire	185(70.1)	68(25.8)	11(4.2)	73.28	13.82
Illegal lumbering and fuelwood	186(70.5)	75(28.1)	03(1.1)	71.69	13.82
Deforestation and climate change	153(58.0)	76(28.4)	35(13.6)	124.49	13.82
Total	1079	442	63	-------	-------

Note: Figures in parentheses are row percentages

Mathematically: X^2 cal = Σ / Expected frequency

Therefore, $X^2 = \Sigma (O-E)^2 / E$

X^2= cal-value> 13.22 @0.99

Table 3: Respondents' Open List of Biodiversity Loss and Exotic Flowers in-around Ikogosi

s/n	Extinct animal	Extinct plant	Exotic flowers
1	Antelope	Loxodonta africana	Raffia palm
2	Red river hog	Loxodonta cyclotis	Double izora
3	Mangabey monkey	Centrosima Phasedoides	Single izora
4	Bat	Waterleaf	Queen of the philipine
5	Duiker	Cassia	Yellow Heliopsis
6	Squirrels	----------	White cactus
7	Deer	----------	Amazon Lily
8	Vulture	----------	Gmelina Arborea
9	Butterfly	----------	Tectona grandis
10	Grasscutter	----------	----------

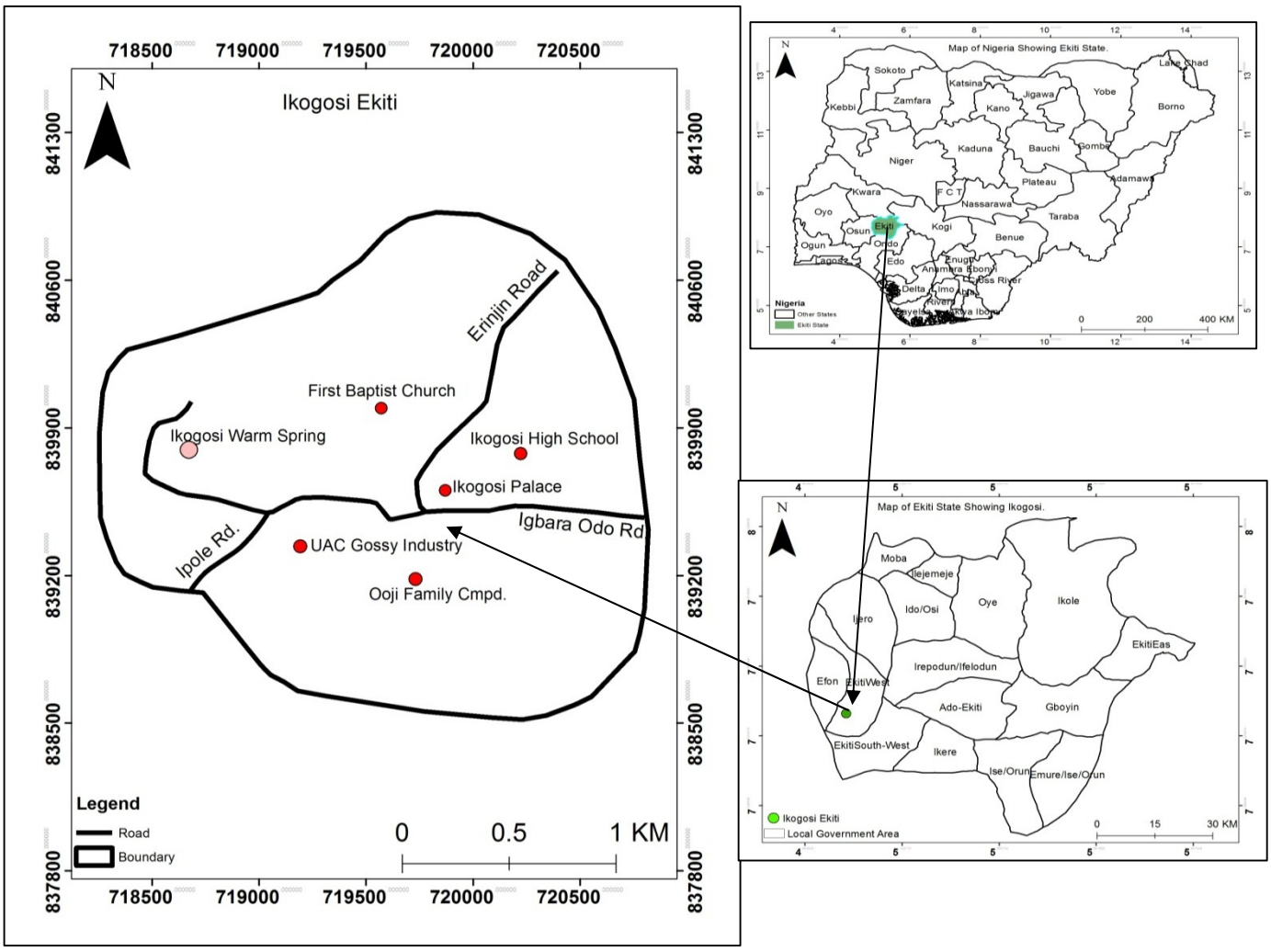

Fig. 1: Ikogosi Ekiti, Ekiti State, Nigeria

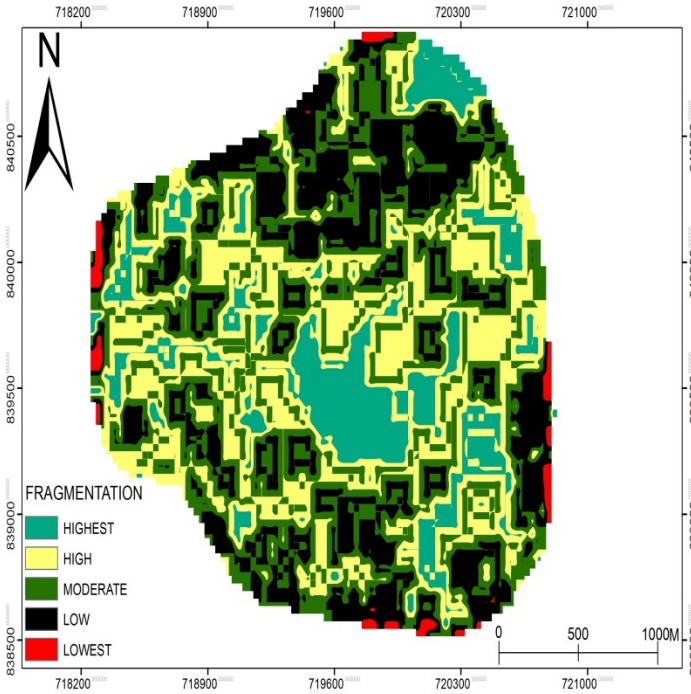

Fig. 2: Fragmentation level in the Ikogosi for 1991.

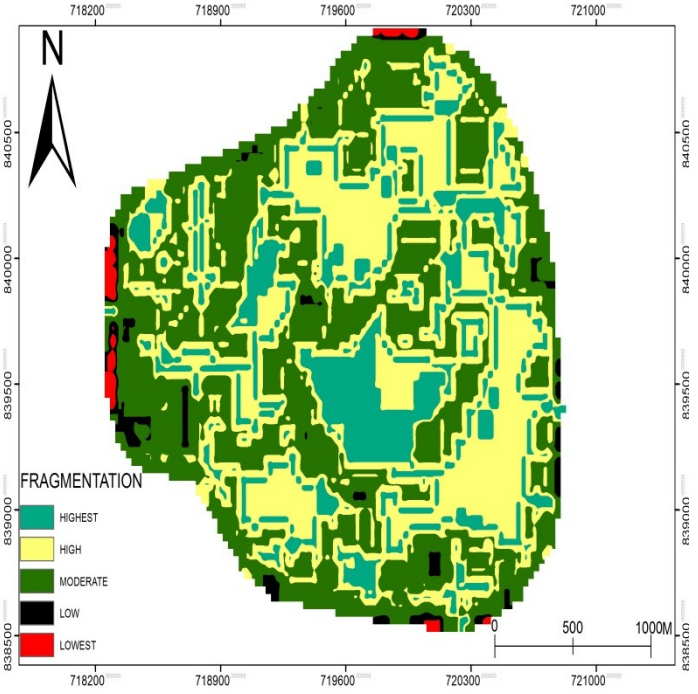

Fig. 3: Fragmentation level in the Ikogosi for 2002.

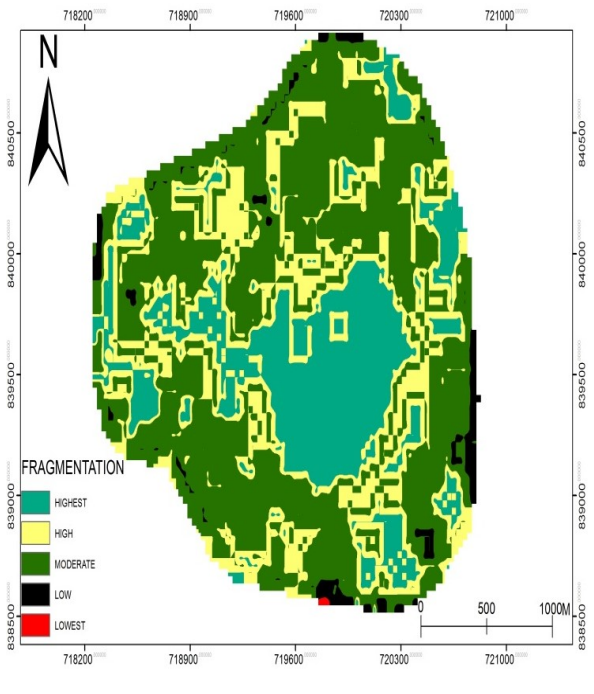

Fig. 4: Fragmentation level in the Ikogosi for 2015.