Implication of Human Induced Activities on Ecotourism in Ikogosi Warm Spring Centre, Ekiti State, Southern western, Nigeria

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Abstract. The magnitude effect of human activities on the environment is of great concern. This study explored geospatial techniques for the assessment of pattern of land use land cover change in Ikogosi Ekiti, South western Nigeria. A 30 meter Landsat image of TM 1991, ETM+ 2002 and OLI 2015 were used for the study. The satellite images were digitally processed using Arcgis10.3 and Idrisi Selva 17.0 while Markov Chain Modeler was employed for prediction. Supervised Classification was performed through Maximum Likelihood Classification resulting into identification of five LULC classes which were built-up, rock outcrop, dense vegetation, light vegetation and water body; fragmentation analysis was done using Fragstat 4.0.

The results showed that anthropogenic activities resulted in 25.93% increase in built-up between the periods of 1991 and 2015 with a substantial loss (29.97%) of dense vegetation within the study area were detected. Fragmentation metric showed that the Number of Patches (NP) increased by 257, 268 and 281 while Shannon Diversity Index (SHIDI) correspondingly showed a decreased of 0.54, 0.47 and 0.21 for species diversity in year 1991, 2002 and 2015 respectively; indigenous respondents (70.1%) affirmed the extinction of biodiversity. Furthermore, the Markov Chain Modeler revealed that built-up was expected to increase by 36.7, 39.1 and 69.6% while dense vegetation will correspondingly decrease by 25.4, 22.9 and 18.7% in year 2030, 2050 and 2065 respectively.

The result revealed that anthropogenic activities in the study area had contributed to massive removal of vegetation and this pattern had negatively affected the biomass condition of the study area indicting the region to experience an ecosystem imbalance and incidence of global warming. The changing spatial pattern was attributed to the tourism developmental phases in-around Ikogosi community which had increased deforestation, exotic plants and poaching by Ikogosi inhabitants and tourist visits to the study area.

The study concluded that various tourism development activities had adversely affected the nature of biodiversity, threatened land-use management and vegetation in the study area.

Keywords: GIS, Remote Sensing, Deforestation, Ecosystem, Forest Degradation, Environment and Habitat Loss.

1. Introduction

Land cover change is one of the most important aspects of environmental change and represents the largest threat to ecological systems over the past several decades (Salami and Mengistu, 2008). The tropical region is of major concern due to the widespread and rapid changes in the distribution and characteristics of tropical forests (Olukoi et al., 2011).

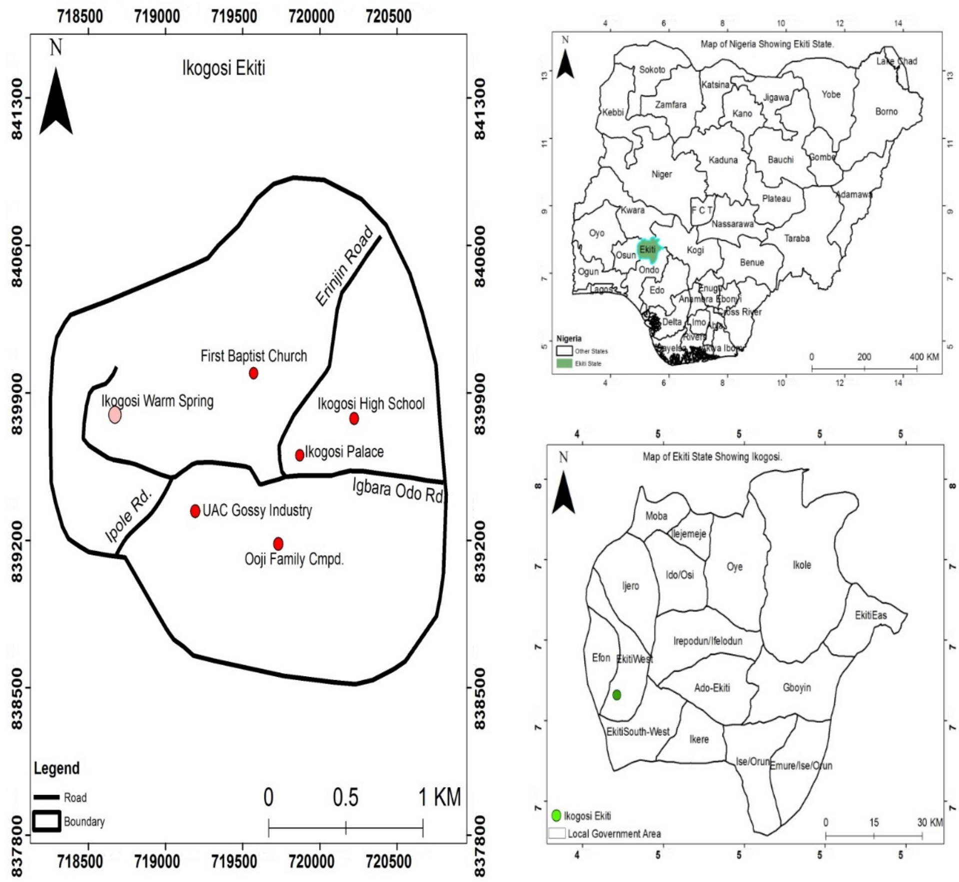

Figure 1: Ikogosi, Ondo State, Nigeria

However many shifts in land use patterns are driven by a variety of social causes, result in land cover changes that affects biodiversity, water and radiation budgets, trace gas emissions and other processes that come together to affect climate and biosphere (Riebsame et al., 1994). Understanding landscape patterns, changes and interactions between human activities and natural phenomenon are essential for proper land management and decision improvement. Changes in land use land cover have important consequences for natural resources through their impacts on soil and water quality, biodiversity and global climatic systems (Adepoju et al., 2006). On the other hand, deforestation and habitat fragmentation have become the most important threats for the maintenance of biodiversity (Adriaens et al., 2006). The process of habitat fragmentation results in changes on the pattern of the remaining forest leading to the loss of ecosystem community and these spatial changes affect the biological population and communities as well as ecological process that may modify the overall functioning of the ecosystem. The magnitude effect of human activities on biodiversity loss is a worldwide concern (Thomas et al., 2004); a primary cause of species loss is habitat destruction and fragmentation (Tilman et al., 2001). Besides, rate of extinctions might be accelerated due to other causes such as invasion by alien species, overexploitation, climate change, habitat deterioration and extinction cascades (Tilman et al., 2001; Thomas et al., 2004; Brook et al., 2008).

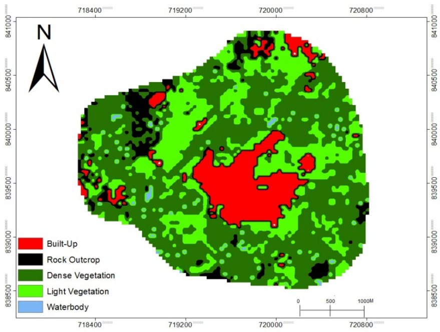

Figure 2: LULC Map of Ikogosi (1991)

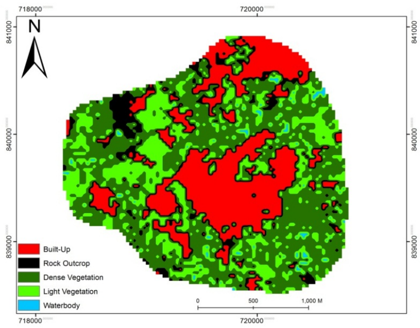

Figure 3: LULC Map of Ikogosi (2002)

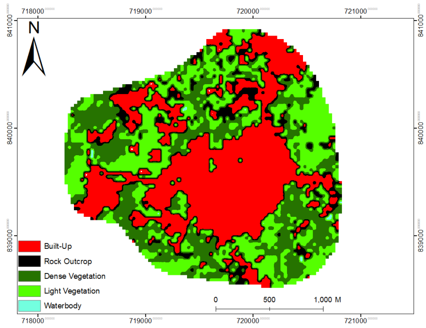

Figure 4: LULC Map of Ikogosi (2015)

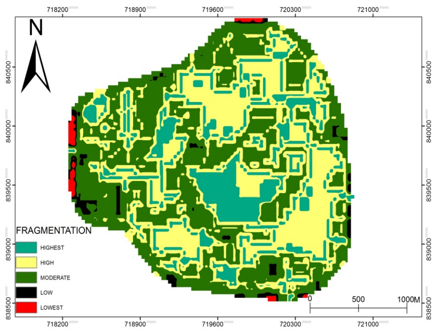

Figure 5: Fragmentation Map (1991)

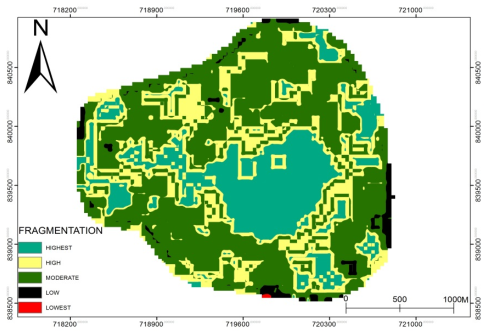

Figure 6: Fragmentation Map (2002)

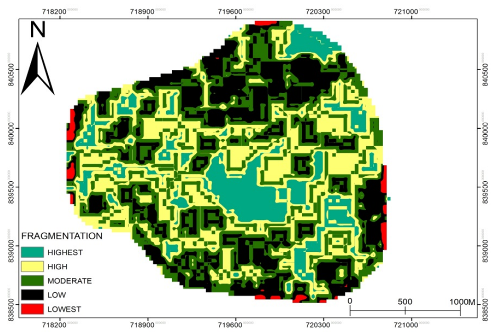

Figure 7: Fragmentation Map (2015)

Remote sensing has an important tool in documenting the actual change in spatial and landscape cover on regional and global scales from the mid-1970s (Lambin et al., 2003). Information on land use land cover and possibilities for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare (Lu et al., 2004). In Nigeria, despite ongoing research efforts by various scholars on land use changes to address loss of biodiversity and forest degradation, there is a still need to quantify the rate and magnitude of natural resources changes due to fast changing urban areas to promote effective forest monitoring and management Therefore, monitoring and managing natural resources as well as urban development has become imperative because it provides quantitative analysis of spatial distribution for biodiversity population. Specifically, the warm and cold spring spot in Ikogosi Ekiti is increasingly experiencing a rapid conversion of land cover in quest for tourism development and this has

Table 1: Change Detection of Land use Land Cover (1991–2015)

LULC Classes	1991		2002		2015	
	Ha	%	Ha	%	Ha	%
Built up	60.48	**13.14**	129.87	**28.22**	169.82	**39.07**
Rock Outcrop	30.51	**6.63**	27.45	**5.96**	24.74	**5.38**
Dense Vegetation	224.51	**53.12**	170.37	**37.02**	106.56	**23.15**
Light Vegetation	116.29	**25.27**	125.62	**27.29**	145.14	**31.54**
Waterbody	8.46	**1.84**	6.94	**1.51**	3.99	**0.87**
Total	460.25	**100**	460.25	**100**	460.25	**100**

triggered deforestation and land cover modification over the last three decades. This study therefore, focuses on providing information on LULC change over a period of 24 years in Ikogosi Ekiti; nature of biodiversity loss and projecting the land cover condition in the next 50 years based on the recent development in the tourism attraction centre and the effects of these changes on the local ecosystem of the region.

2. Study area

2.1. Ikogosi at a glance

Ikogosi Ekiti is in Ekiti State, South Western, Nigeria. Ikogosi Ekiti is located on Latitude 7°35′ N and 7°34′ N, Longitude 4°58′ E and 4°59′ E and the elevation of Ikogosi ranges from 457.0–487.5m above sea level (Olorunfemi and Raheem, 2008). Ikogosi is selected as the study site based on her natural warm and cold spring which attracts visitors to the tourist center for leisure, 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 the cultivation and growing of perennial crops has distinguished the area as an agro-forested area. Ikogosi Ekiti is a rural center with linear 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. Numerous tourists visit the place to enjoy the luxurious warm and cold swimming pool 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.

3. Materials and methods

3.1. 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 were acquired respectively. 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, 2015 and March, 2016 using Global Positioning System (GPS). In addition, semi structured questionnaire was administered to the local respondents in Ikogosi and some selected officers in the Ministry of Tourism and Environment, Ado Ekiti. This was with the view of augmenting the available information from the satellite image analysis and to obtain the information from the local populace on the subject of the study. A total of 270 copies of questionnaire were administered but 264 copies were successfully retrieved by the questionnaire administrator and chi-square was employed for analysis.

3.2. Image Analysis

The satellite images were subjected to resampling and enhancement before supervised classification using Maximum Livelihood was carried out. Training sites corresponding to each classification item (land use class) were chosen; Five LULC types were defined for supervised classification: built-up area, rock outcrop, dense vegetation, light vegetation and waterbody. Furthermore, classified imageries of Ikogosi for year TM 1991; ETM+ 2002 and OLI 2015 were developed into grid cell with the help Patch Analyst. Patches were categorized under five classes: Lowest (<25 ha), Low (25-50 ha), Moderate (50-100 ha), High (100 - 200 ha) and Highest (>200 ha). Five landscape levels metric were chosen to quantify for spatio-temporal changes in Ikogosi landscape composition and configuration among the classified imageries. The five landscape indices of fragmentation defined for the study were: Number of Patches (NP), Patch Density (PD), Largest Patch Index (LPI), Shannon's Diversity Index (SHIDI) and Simpson's Diversity Index (SIDI). The study made a projection based on the existing classified imageries of the study area using Markov Chain Modeler. The change between the classified images of TM 1991 and OLI 2015 was the basis for Transition matrix of LULC classes and with this; Markov chain Modeler predicted the LULC change for the year 2030, 2050 and 2065. The results were explained using maps, charts and tables.

4. Results and discussion

4.1. Land Use Land Cover (LULC) Patterns in the Study Area

The land use land cover was classified into five categories namely: built-up, rock outcrop, dense vegetation, light vegetation and waterbody. Table 1 revealed area calculations and the entire study area coverage which was 460.25 ha. In the periods considered accordingly, dense vegetation (53.12%), light vegetation (25.27%), built-up (13.14%) showed the percentage coverage of each class in the total land area for 1991. In 2002, built-up increased significantly by 28.22% of the total land area. Light vegetation 27.29% while dense vegetation decreases to 37.2% in the study area, the remaining land classes of rock outcrop and waterbody slightly decreased with 5.96% and 1.51% respectively of the total area. Lastly, in 2015 built-up and light vegetation experienced continued increase with 39.07% and 31.54% respectively of the total area. Rock outcrop accounted for a marginal decrease of 5.38% and dense vegetation decrease with 23.15% in the total area. Lastly, in 2015 built-up and light vegetation experienced continued increase with 39.07% and 31.54% respectively of the total area. Rock outcrop accounted for a marginal decrease of 5.38% and dense vegetation decrease with 23.15% in the total area. Waterbody maintained a slight decrease with 0.87% of the total area. The changes in the land use pattern have a corresponding effects (either decrease or increase) on the land cover in another land-use class. The continuous conversion of vegetation to built-up showed a high rate of human activities and landscape development for supporting the growing need of tourism facilities in the study area. The outcome of this study corroborates with Lopez et al. (2001) which found out that there is linkage between population growth and land cover conversion in any area of natural attraction. In respect to light vegetation expansion over the years, this is attributed to the conversion of light forest to agricultural lands in solving food security issues thus supporting the growing population of tourists and indigenes in the study area. Arvind et al. (2006) opined that peasant farmers engaged in shifting cultivation and bush burning as a pre-planting operation therefore reducing the biomass condition in the study area. Resultant ecological effect of this has exposed the land to losing its soil micro-organism leading to ecosystem malfunctioning. Olaniran (2002) described deforestation problems in Nigeria to be causing erosion which is adversely affecting the nature and environment.

4.2. Markov Chain Analysis for LULC Projection

Result of Markov chain analysis in Table 2 showed the statistics of land use land cover projection for year 2030, 2050 and 2065. Result shows that in year 2030, built-up accounts for the highest portion of land use change with an increment of 36.7% while rock outcrop 7.5%. Dense vegetation occupies 25.3% and light vegetation 30.2% of the total land area while waterbody remains at 0.2% By 2050; built-up increases with 39.1%; rock outcrop reduces with 6.6% of the total land area. Dense vegetation accounts for a decrease of 22.9% as light vegetation increases with 31.2% and waterbody remain at 0.2% of the total land area. Lastly in year 2065, built-up accounts for an increase of 69.6%; rock outcrop will be 3.6% while dense vegetation stands at 7.9% and light vegetation 18.7% of the total land area. In addition, waterbody maintain 0.2% of the total land area for the projected land cover status. Comparatively, results for the predicted years showed that built-up extending from the centre of year 2030 towards the north and west axis in 2065 (see Figure 8, 9 and 10); this showed a true continuation in the pattern of land use changes particularly from the classified image of 1991 to predicted map of 2065 (see Figure 11). The basis for the results were not far-fetched; increasing influx of tourist and population growth in the study area gave rise to provision of more tourism facilities in supporting the number of tourists and residential growth; with the impact on the land cover conversion into housing facilities and other basic amenities as anticipated by Adeniji and Omojola, (1999). Noteworthy in this study suggested that built-

Table 2: Area Prediction of LULC Change by year 2030, 2050 and 2065

LULC Classes	1991		2002		2015	
	Ha	%	Ha	%	Ha	%
Built-up	179.20	**36.7**	189.82	**39.1**	320.12	**69.6**
Rock Outcrop	34.74	**7.5**	25.56	**6.6**	16.74	**3.6**
Dense Vegetation	116.36	**25.4**	95.56	**22.9**	36.36	**7.9**
Light Vegetation	139.14	**30.2**	148.32	**31.2**	86.04	**18.7**
Waterbody	0.99	**0.2**	0.99	**0.2**	0.99	**0.2**
Total	460.25	**100**	460.25	**100**	460.25	**100**

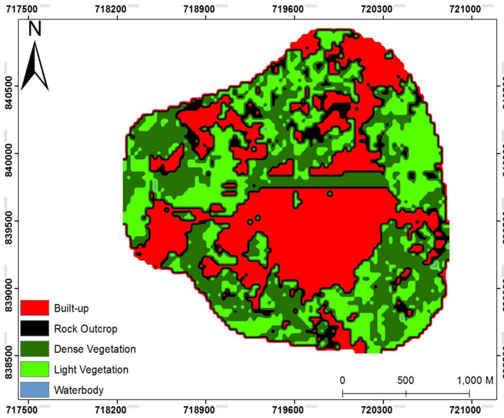

Figure 8: LULC change predicted for 2030

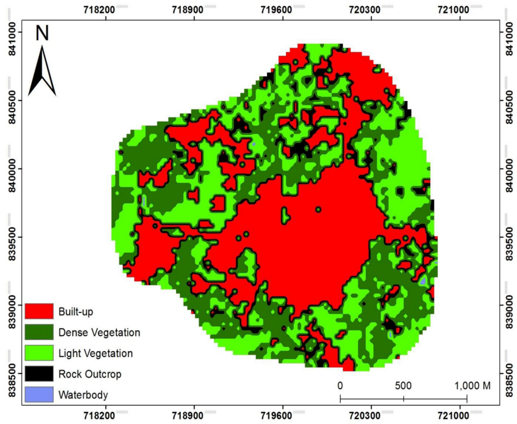

Figure 9: LULC change predicted for 2050

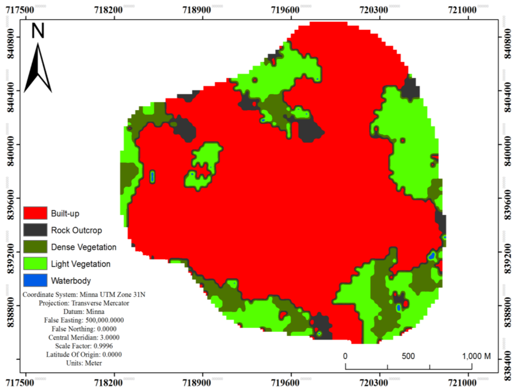

Figure 10: Map of the LULC change predicted for 2065

up was found replacing and transiting the land natural cover of this area gaining more from forested land cover. This phenomenon according to Gbehe (2004), has resulted into numerous issues such as physical expansion and degradation of surrounding lands as noted by Zubair (2006); especially from dense and light vegetation. Consequently, increased tourist population has mounted pressure on land available for agricultural purpose to meet the food security of the growing population in Ikogosi community. The result of the study was in accordance with Zubair (2006); Chang and Chang (2006) that presumed increase in impervious surface because of more built-up area have the tendency of increasing the surface runoff thereby creating environmental problem of soil erosion and eutrophication to the riparian waterbody been enhanced by poor drainage system.

4.3. Habitat Fragmentation and Impact on Biodiversity Loss

The findings revealed the rate of biodiversity loss because of habitat fragmentation in the study area. Table 3 showed that Number of Patches (NP) increase in the years 1991, 2002 and 2015 as (257, 268 and 281) respectively. Also, Patch Density (PD) increased 14726; 16809 and 19002 and Largest Patches Density (LPI) of 16.09, 22.78 and 29.01 respectively for year 1991, 2002 and 2015. The findings from the study showed increase in the NP, PD and LPI

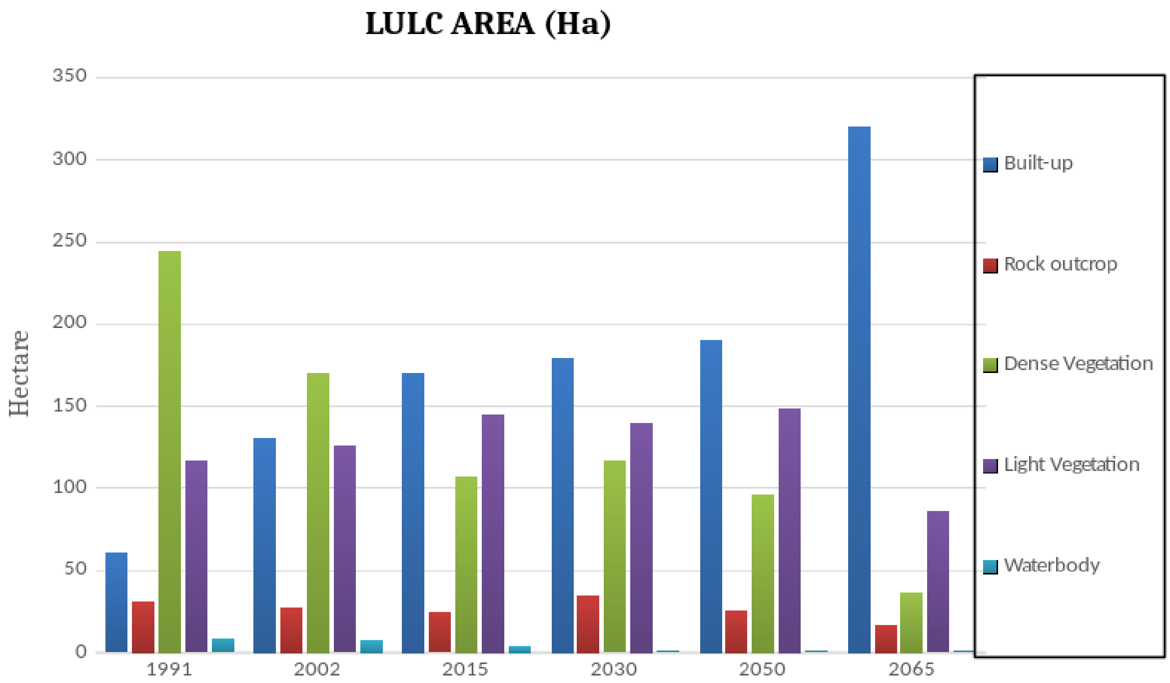

Figure 11: LULC Change for year 1991, 2002, 2015, 2030, 2050 and 2065.

between the years 1991 and 2015 have been associated to the human activities around the study area. It is a response to socio-economic constraints that forced local residence into activities like farming, deforestation, lumbering and construction activities in-around the Warm Spring Resort Centre and entirety of Ikogosi community; connoting an element of increased habitat loss and artificial patches within the forested land in the entire study area. Moreover, Shannon-Wieneer Index (SHIDI) revealed a decrease in the species diversity as values remained at 0.54, 0.47 and 0.37 for the year 1991, 2002 and 2015 respectively. 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. Consequently, results from both Shannon-Wieneer Index and Simpson Diversity Index showed that habitat fragmentation has reduced the plant diversity, species evenness and dominance concentration as more fragmentation occurred between 1991 and 2015. This implied species diversity reduces in respect to the number and density of patches; and impervious surfaces increment observed

Table 3: Landscape Metric of Fragmentation Levels in Ikogosi

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 within the study area.

4.4. Surveyed Perceptive on Biodiversity Loss in Ikogosi

Table 4 gives a summary of a surveyed respondents' perception on the impact the tourism has on the trend of biodiversity loss in the study area. As contained in the Table 4, vegetal removal due to construction of infrastructural facilities were 66.83 > 13.82, agricultural practices and habitat loss accounted for 104.63>13.82, increase in the exotic species such as ornamental plant for beautification 53.79 > 13.82, poaching and wildfire by peasant farmers were 73.28 >13.82 in the study area. Furthermore, illegal logging and fuel wood for energy production were 71.69 > 13.82 and incidence of climate change owing to deforestation were 124.49 >13. 82 as confirmed by the respondents. In all cases analyzed, the calculated values varied significantly (T(0.01)=13.82; P<0.01); thus, indicating a high level of awareness of biodiversity loss as a result of human activities in quest for tourism development in the study area which threatened habitat and biodiversity loss; and other associated environmental problems as revealed by the respondents. Consequential impact revealed that fragmented habitats tend to host limited number of 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. In agreement with Fuwape (2004) that fire wood which is mainly derived from natural forest perhaps resulted from the activities of wildfire and hunting for bush meat by local farmers. However, these activities have deteriorated the biodiversity condition of the natural forest making migration of wildlife fasten from the corridor of their habitat into the core of the remnant forest environment. Sada and Odemerho (2008) particularly explained this as an adverse environmental condition of fauna and flora extinction, prevalence of soil erosion and change in climatic pattern because of reduced biomass quantity in the study area.

Table 4: Perception on Impact of Tourism and Biodiversity Loss in Ikogosi

Element	Agree (%)	Disagree (%)	No Idea (%)	Calculated values	Table values
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

5. Conclusions

The study accounted for general trend in LULC changes revealing decrease in dense and light forest with a corresponding increase in built-up area. Consequently, Ikogosi Warm Spring

Resort operates on a negative impact on the host community, natural resources and biodiversity. The study concludes that the emergence of Ikogosi Warm Spring Resort has created ecological problems to the immediate local community in terms of deforestation, species extinction, soil erosion, habitat fragmentation and incidence of climate change as a result of various developmental activities from tourism developer in the study area. In addition, it is also important to recall that regrowth forest has been incessantly encroached thus creating habitat fragmentation around the study area. The implications were significantly high on the carbon stock and biodiversity loss denoting an unusual increase in the greenhouse gas in the upper atmosphere. Finally, it is obvious that more land cover will witness conversion in the future especially built up will score highest land use class in the future as a result population growth and tourist excitement in Ikogosi Warm Spring. Conclusively, it has been noted that land degradation is both a part and consequence of environmental changes leading to loss of valuable land resources.

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