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Land use/land cover dynamics around ecotourism attractions and support facilities in Ikogosi Warm Spring Resorts, Nigeria

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ABSTRACT

This study focused on creating aspatial and spatial attributes of the ecotourism attractions and support facilities, as well as detecting the land use/land cover change around each ecotourism attractions and support facilities of Ikogosi Warm Spring Resorts, Nigeria. Secondary data collection method, remote sensing and geographic information technology were employed. LANDSAT imageries of two-time series (2002 and 2017) were acquired and subjected to supervised image classification in ArcGIS 10.4 software environment. A total of twenty-two ecotourism attractions/support facilities and four categories of land cover/land use were identified. Closed secondary/riparian forest covered the highest land mass of 28.11 hectares (46.84%) around the ecotourism attractions and support facilities in 2002, while the open secondary forest covered the least land mass of 0.34 hectares (0.57%). Much more, closed secondary/riparian forest covered the highest land mass of 24.37 hectares (40.62%) in 2017, while the open secondary forest covered the least land mass of 7.92 hectares (13.20%). Thus, degraded vegetation/farmland/lawn was the only land cover/land use classes that experienced negative absolute change (-151,009.55 hectares), percentage change (-4.69%), the rate of change (8.76%) and annual degradation change (-0.081). The study concluded that there was a slight increment in the indicator of ecotourism's ecological impact (built-up areas/bare ground) within the time span of fifteen years most especially around some chalets and lodges. However, caution should be taken by the resort's authority to curb the increment in this indicator through the adoption of sustainable approaches in the design and development of ecotourism attractions and support facilities.

Keywords: Ecotourism attractions; deforestation; support facilities; GIS

INTRODUCTION

Land use and land cover changes are important indicators of the way, intensity and impact of humans' interaction with their environment (Valbuena *et al*., 2008; Ruiz-Martinez *et al.*, 2015; Audrey *et al.*, 2016). These changes lead to transformations in the hydrological, ecological, geomorphologic and socio-economic systems, and are often neglected by relevant administrations (Chazdon *et al.*, 2009; Olofsson *et al.*, 2013). The impact of these changes can sometimes have negative impacts, such as land degradation and climate change (Lambin *et al*., 2006). Therefore, land use change leads to environmental change and which in turn affects the land use practices, land degradation and habitat fragmentation (Shaw *et al*. 2002; Wardle *et al.* 2003; Chazdon *et al.*, 2009; Maitima *et al.*, 2009; Arunyawat and Shrestha, 2016; WoldeYohannes *et al.*, 2017). The continuous changes due to the nature and human activities such as population increase and the search for more productive agricultural lands, remain the drivers to land use and land cover dynamics.

In Nigeria, being a tropical country, one of the prominent characteristics of land use/cover change (LUCC) is the decline in forest and woodlands (Ellis, 2011; Obayelu, 2014). Settlement expansion and agricultural expansion for cash crop production have become central driving forces to land use/land cover dynamics (Abebe, 2013; Suleiman *et al*., 2014; Shi *et al.*, 2018; Gong *et al.*, 2018). However, ecotourism development is seen as an alternative, sustainable development initiative and an integral aspect of the process towards indigenous control, self-reliance and improvement of social and economic conditions of the host communities to ecotourism destinations (Gumus *et al.*, 2007; Kumari *et al.*, 2010; Abdolreza *et al*., 2013; Kiper, 2013). Its activities can create various negative impacts and irreversible changes on the ecologically fragile areas, in the form of degrading natural resources, vegetation structure and the size of the habitat patch, increasing deforestation and decreasing upstream water flows (Tourism Queenland, 2002).

The land use/land cover dynamics within an ecotourism destination in recent times require a more powerful and sophisticated system such as remote sensing technology and Geographic Information System (GIS) to provide a general extensive synoptic coverage of large areas (Tewodros, 2010). GIS is one of the most amazing technologic advances in the ecotourism planning as a decision supporting tool. It had been employed in many tourism issues such as visitors flow management, tourism site selection, impact evaluation and sustainable tourism plans (Fung and Wong, 2007; Rahman, 2010; Lee *et al.*, 2010; Hai-ling *et al*., 2011; Nutan, 2014; Wang, 2014; Ahmadi *et al.*, 2014; Olaniyi *et al*., 2016; Dhami *et al.,* 2016). Thus, information on land use/land cover extracted by GIS can be essential for the selection, planning and instigating more appropriate policy interventions for an ecotourism destination (Krishna *et al*., 2001; Ellis and Pontius, 2007; Munyati and Makgale, 2009; Perera *et al.*, 2011). Therefore, this study aimed at creating aspatial and spatial attributes of the ecotourism attractions and support facilities, and detecting the land use/land cover change around each ecotourism attractions and support facilities of the study area.

METHODOLOGY

Study area

The study area (Figure 1) is situated at the latitude of 7° 35' 38.9" and the longitude of 4° 58' 52.6". It has an average elevation of 479m above mean sea level, underlain by a group of slightly migmatized to non-migmatized paraschists and meta-igneous rocks (Caby and Boesse, 2001; Ikudayisi *et al.,* 2015). The resort is located at Ikogosi-Ekiti, a small hub with inhabitants predominantly farmers engaged in planting food crops (Coco-yam, Plantain, Maize, Yam, Cassava and Banana among others) and cash crops (cotton, cocoa, and coffee) (Okosun *et al.,* 2016). However, it is an awesome site where two different springs flow side by side without disturbing each other (Godfrey and Clarke, 2000; Ikudayisi *et al.,* 2015). The warm spring with a temperature of up to 70^{o}C at the source and 37^{o}C after meeting the cold spring is a unique attraction to tourists (Jimoh, 2011).

Data collection and analysis

Secondary data collection method were employed to collect the aspatial information on ecotourism attractions and support facilities of the study area from the resorts' authority, while the spatial data were collected through on-field observation with the aid of a hand-held Global Positioning System device (GARMIN 78S). Landsat 7 ETM+ and Landsat 8 OLI/TIRS imageries of two-time series with a spatial resolution of 30m captured in January 2002 and 2017 respectively were acquired and subjected to supervised image classification in ArcGIS 10.4 software environment to derive the land use/land cover of the ecotourism

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destination. Based on the priori knowledge of the study area which spans more than 20 years coupled with recent ground truthing exercise, the International Geosphere Biosphere Programme (IGBP) land cover classification system was adopted and modified into four land cover/land use classes with associated attributes shown on Table 1 - built-up/bare ground, open secondary forest, closed secondary/riparian forest and degraded vegetation/farmland/lawn. Ground truth data were collected using GARMIN 78S hand-held GPS receiver for training samples and accuracy assessment of classification results. Error matrices and kappa statistics were computed using ERDAS Imagine 2014 software and the results are presented in Table 2. The overall accuracies (kappa statistics) of 2002 and 2017 were 84.72% (0.7524) and 82.47% (0.7627) respectively.

Post-classification comparison method was used in the change detection analysis, that is, the images were classified separately and classifications at different dates are compared in order to generate a complete change matrix (Lu *et al*., 2004). The annual degradation rate for each land use/land cover class was calculated with formula (Puyravaud, 2003) stated below:

$$r = \left(\frac{1}{t_2 - t_1}\right) \times ln\left(\frac{A_2}{A_1}\right) \tag{1}$$

Where r is the change for each class per year, A_2 and A_1 are the class areas at the end and the beginning, respectively, for the period being evaluated, and t is the number of years spanning that period.

Rate of change of land use/land cover area for the two periods was calculated using the following equations:

$$Absolute\ change = Final\ time\ matrice - Initial\ time\ matrice \tag{2}$$

$$Percentage\ Change = \frac{Absolute\ change}{Initial\ time\ matrice} * 100 \tag{3}$$

$$Rate\ of\ change = \frac{Percentage\ change}{Time\ difference} \tag{4}$$

Thereafter, a buffering tool in ArcGIS 10.4 ArcToolbox was used to create a concentric feature with a radial distance of 100m around the identified ecotourism attractions and support facilities. Each of the buffered resultant polygons was overlaid on the classified land use/land cover imageries of the study area in order to mask the areas of interest (that is, adjacent environment to the ecotourism features) out of the whole area using the ArcGIS 10.4 masking tools.

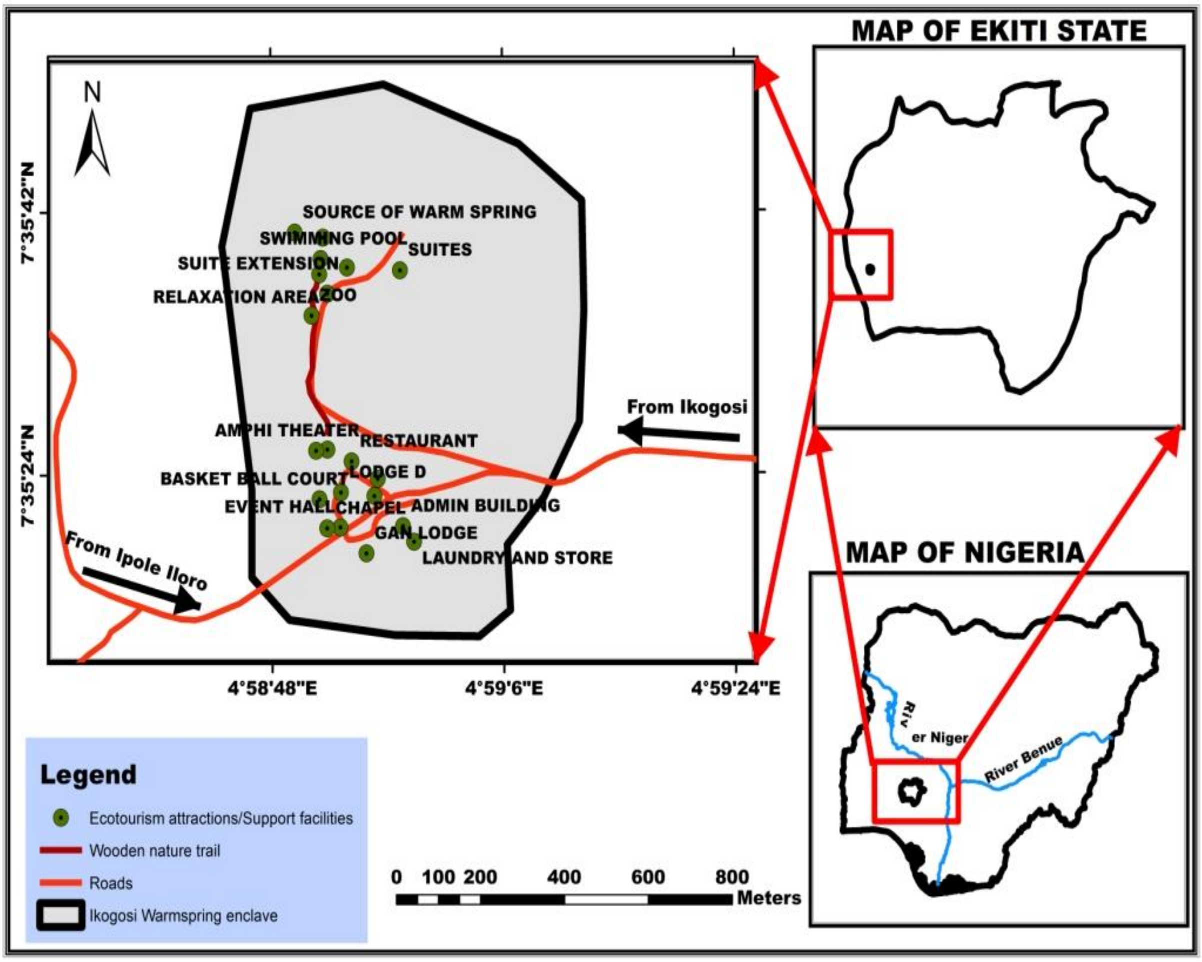

Figure 1: Location of Ikogosi Warm Spring Resort in Ekiti State, Nigeria

Modified class name	Related IGBP class name	Description
Built-up/Bare ground	Urban and built-up lands, Barren	Land covered by buildings and other man-made structures. Lands with exposed soil, sand, rocks, or snow and never have more than 10% vegetated cover during any time of the year.
Open secondary forest	Mixed forests	Lands dominated by trees with a percent cover >60%, height exceeding 2 m and consisted of tree communities with interspersed mixtures or mosaics of the other four forest types. None of the forest types exceeds 60% of landscape.
Closed secondary/Riparian forest	Evergreen broadleaf forests, Permanent wetlands	Lands dominated by broadleaf woody vegetation with a percent cover >60% and height exceeding 2 m. Almost all trees remain green year round. Canopy is never without green foliage. Lands with a permanent mixture of water and herbaceous or woody vegetation.
Degraded vegetation/farmland/Lawn	Grasslands, Croplands, Cropland/natural vegetation mosaics	Lands with herbaceous types of cover. Tree and shrub cover is less than 10%. Lands covered with temporary crops followed by harvest and a bare soil period (e.g., single and multiple cropping systems). Lands with a mosaic of croplands, forests, shrubland, and grasslands in which no one component comprises more than 60% of the landscape.

Table 1: The land cover classification scheme used in the supervised image classification

Table 2: Error matrix of 2002 and 2017 classified land use/cover maps for Ikogosi Warm spring Resort, Nigeria

Classified data	2002		2017	
	User's Accuracy (%)	Producer's Accuracy (%)	User's Accuracy (%)	Producer's Accuracy (%)
Built-up/Bare ground	85.00	80.95	90.00	96.77
Open secondary forest	82.93	94.44	85.00	65.00
Closed secondary/Riparian forest	100.00	63.64	72.00	84.62
Degraded vegetation/farmland/Lawn	100.00	75.00	90.00	75.00
Overall Accuracy (%)	84.72		82.47	
Overall Kappa Statistics	0.7524		0.7627	

Results and Discussion

Table 3 presents the aspatial and spatial attributes of the ecotourism attractions and support facilities of Ikogosi Warm Spring Resort, Nigeria. A total of twenty two ecotourism attractions and support facilities were identified at the study area. Three ecotourism attractions (Confluence of Warm and Cold Springs, joint tree and source of Warm Spring) had been in existence for over 700 years, while twelve ecotourism attractions and support facilities were the most recently constructed (year 2010). However, most of the support facilities underwent renovation exercise between 2010 and 2012 with a total of twelve ecotourism attractions and support facilities renovated in year 2012. The ecotourism attractions and support facilities were re-packaged and built respectively with nine construction materials – cement, sand, stone, raffia palm, *Lophira alata* wood, tiles, glass, metals and bricks. The event hall had the highest carrying capacity (500), while the relaxation area had the least carrying capacity (10). Generally, most ecotourism attractions and support facilities experienced low intensity of usage/patronage except, the reception/ticket stand, walkway, administrative building, laundry and store, swimming pool, Dick Jockey spot, confluence of Warm and Cold Springs, joint tree, Monkey spot and source of Warm Spring. Presently, most ecotourism attractions and support facilities within the ecotourism destination experienced low to moderate level of maintenance. Notwithstanding, factually all the attractions and facilities are in good conditions, except the few (Chalets, Gan lodge, chilling spot, basketball court) in dilapidated form.

These research findings showed that the ecotourism destination witnessed major developmental changes and renovation between 2010 and 2012. This was due to the intervention of Ekiti State Government during the period to resuscitate and transform the moribund ecotourism sector in the state (Olaniyi and Ogunjemite, 2015). Most of the attractions and support facilities at Ikogosi Warm Spring Resorts received a moderate level of maintenance and thus were in good condition. Similarly, ecotourism attractions and support facilities had been constructed and maintained recently in few other ecotourism destinations such as National Parks in South Africa (South African National Parks, 2013), Taman Negara National Park, Malaysia (DWNP, 2013), Nyungwe National Park, Rwanda (USAID/Rwanda, 2012), Kakum National Park, Ghana (Akyeampong, 2009), Obudu Cattle Ranch, Nigeria (Terwase *et al.,* 2015). The improvement of these facilities created a basis for the development of ecotourism sector and image enhancement of the Ekiti State government. According to Adebayo and Iweka (2014); Jovanovic and Ilic (2016), strong relationship existed between tourism development and infrastructure, that is, tourism infrastructure forms the basis of tourism development, in addition to a base for sustainable resources utilization in ecotourism destination.

Figure 2 and Table 4 depict the pictorial representation and attributes of the land use/cover of Ikogosi Warm Spring Resorts in 2002 and 2017. Four categories were identified - built-up/bare lands, open secondary forest, closed secondary/riparian forest and degraded vegetation/farmland/lawn. Closed secondary/riparian forest covered the highest land mass of 430, 681.95 hectares (52.61%) in 2002, while the open secondary forest covered the least land mass of 55, 302.45 hectares (6.75%). Closed secondary/riparian forest covered the highest land mass of 448,062.72 hectares (54.73%) in 2017, while the degraded vegetation/farmland/lawn covered the least land mass of 63,428.53 hectares (7.75%). Figure 3 and Table 5 show the pictorial representation and attributes of land use/land cover around ecotourism attractions and support facilities of Ikogosi Warm spring Resorts, Ekiti State. Closed secondary/riparian forest covered the highest land mass of 28.11 hectares (46.84%) in 2002, while the open secondary forest covered the least land mass of 0.34 hectares (0.57%). Also, closed secondary/riparian forest covered the highest land mass of 24.37 hectares (40.62%) in 2017, while the open secondary forest covered the least land mass of 7.92 hectares (13.20%).

The predominant closed secondary/riparian forest land cover in Ikogosi Warm Spring Resort in 2002 and 2017 depicted its general vegetation landscape situated within ecological rainforest belt of Southwest Nigeria. Similarly, this land cover occupied the largest landscape around the ecotourism attractions and support facilities in the resort. However, previous studies revealed that the vegetation of the study area is predominantly thick high forest and situated within the tropical rainforest ecological zone in the southern part of Ekiti State, Nigeria (Ibimilua, 2009; Aiyeloja and Bello, 2012; Agbelade and Fagbemigun, 2015).

The parameters of land use/land cover dynamics around ecotourism attractions and support facilities in Ikogosi Warm Spring Resort, Ekiti State were presented in Table 5. The open secondary forest had the highest positive absolute change (72, 683.22 hectares), percentage change (131.43%), rate of change (8.76%) and annual degradation change (0.056), while closed secondary/Riparian forest had the least positive absolute change (17,380.77 hectares), percentage change (4.04%), rate of change (0.27%) and annual degradation change (0.003). However, degraded vegetation/farmland/lawn was the only land cover/land use class that experienced negative absolute change (-151,009.55 hectares), percentage change (-4.69%), rate of change (8.76%) and annual degradation change (-0.081).

Much of the contribution to the highest positive absolute change, percentage change, rate of change and annual degradation change of open secondary forest around the ecotourism attractions and support facilities in the resort was the clearance of the closed secondary/riparian forest land cover majorly for the purpose of ecotourism infrastructural development and renovation within the period of 2010 to 2012. Other studies revealed that increased human interference such as tourism activities in ecologically sensitive areas can create various irreversible change and negative impacts on the surrounding environment and existing ecological processes with degrading natural resources, vegetation structure and the size of the habitat patch, increasing deforestation (Tourism Queenland, 2002; Olaniyi, 2017).

Figure 4 and Table 6 show the pictorial representation and attributes of the transition matrix of the land use/land cover dynamics around ecotourism attractions and support facilities in Ikogosi Warm Spring Resort, Ekiti State. The highest transition in land cover mass of 8.52 hectares (14.19%) was experienced from degraded vegetation/farmland/lawn to closed secondary/riparian forest, while the least transition in land cover mass of 0.39 hectares

(0.66%) was experienced from built-up/bare ground to closed secondary/riparian forest. However, most land cover/land use classes experienced no changes with land cover mass of 28.53 hectares (47.56%).

Although, degraded vegetation/farmland/lawn and built-up/bare ground also experienced drastic regeneration to the open secondary and closed secondary/riparian forests over the period of 15 years due to the conservation efforts by the resort authority. Various past submissions had itinerated the possibility of restoration of agricultural lands to forest lands (Chapman and Chapman, 1999; Shames *et al.*, 2014; Delgado *et al.*, 2015). The conversion of abandoned secondary forest and marginal agricultural lands to closed forest was witnessed in Southern Ontario, Canada (Burke *et al.,* 2011). This ecological restoration was actualized through the restriction of agricultural activities to certain adjoining portion with less environmental impact on the hydrological chemistry of the warm and cold springs

Figure 5 presents the transition matrix of the land use/land cover dynamics around each ecotourism attraction and support facility in Ikogosi Warm Spring Resort, Ekiti State. Most land cover/land use classes experienced no changes in land cover mass from 2002 to 2017. Thus, the chalets experienced no changes with the highest land cover mass of 2.51 hectares, while Amphi theatre experienced no changes with the least land cover mass of 0.81 hectares. Generally, the transition from built-up/bare ground to closed secondary/riparian forest around each ecotourism attraction and support facility occupied the least land cover mass.

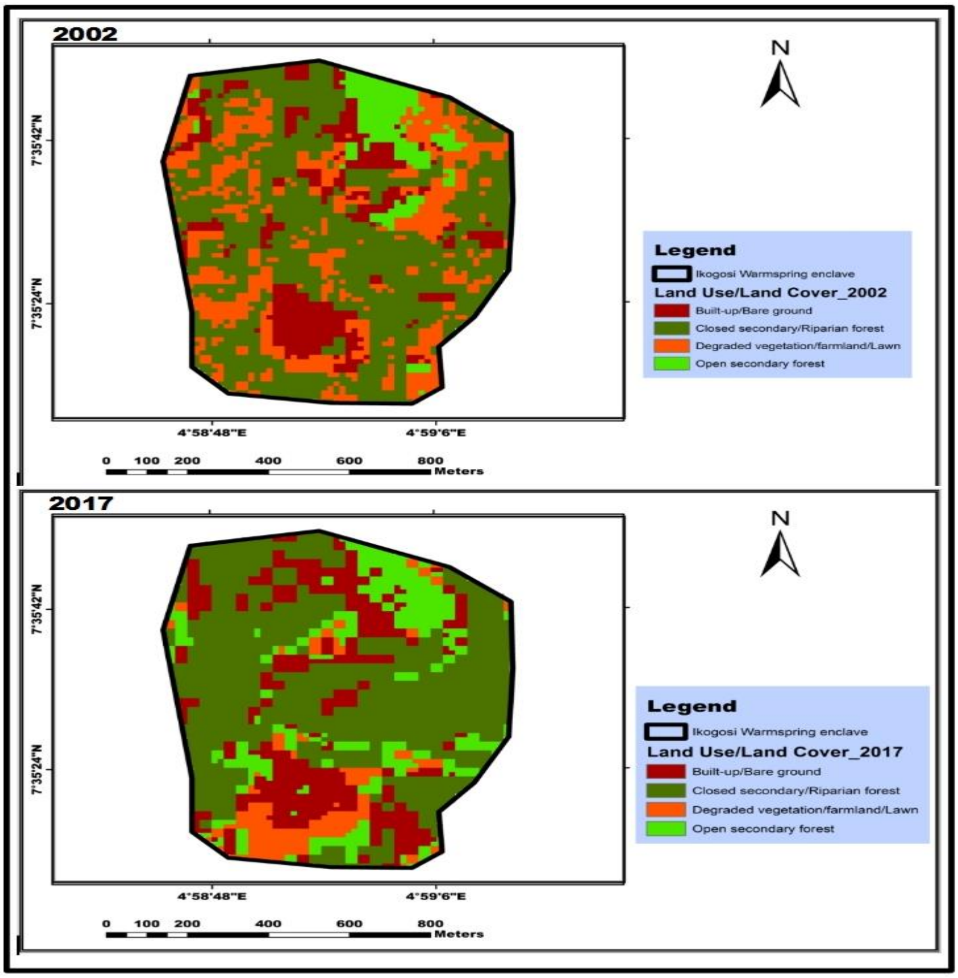

Figure 2: Land use/land cover of Ikogosi Warm Spring Resorts in 2002 and 2017

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Table 3: Aspatial and spatial attributes of the ecotourism attractions and support facilities in Ikogosi Warmspring Resort, Nigeria

S/N	Ecotourism attractions/support facilities	Location Coordinates		Year of construction/ renovation	Construction material	Carrying capacity	Intensity of usage/patronage	Level of maintenance	Status of attractions
		Latitude	Longitude						
1	Event hall	7.589194	4.981500	2010/2012	Cement	500	Low/seasonal	Low satisfactory	Good condition
2	Restaurant	7.590250	4.981750	1952/2010	Cement/bricks/ stone	100	Low	Moderate	Good condition
3	Chapel	7.589222	4.981250	1952/2010	Cement/bricks/ stone	150	Low	Low	Good condition
4	Chalet	7.589889	4.982222	1952/2010	Cement/stone		Low	Low	Decapitated/good
5	Reception/ticket stand	7.590500	4.981278	2010/2012	Wood/raffia/cement		High	Moderate	Good condition
6	Walkway	7.594500	4.980944	2010/2012	Wood		High	Low	Good condition
7	Administrative building	7.589028	4.982778	1952/2010	Bricks/cement		High	Moderate	Good condition
8	Laundry and Store	7.588944	4.982944	2010/2012	Cement/sand		High	Moderate	Good condition
9	Suites	7.593917	4.982611	2010/2012	Cement/sand	4/room	Low	Low	Good condition
10	Gan lodge	7.593861	4.982611	1977/1978			Low	Low	Dilapidated
11	Swimming pool	7.594111	4.981056	2010/2012	Tiles/cement/water		High	High	Good condition

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Table 3 (Cont'd): Aspatial and spatial attributes of the ecotourism attractions and support facilities in Ikogosi Warmspring Resort, Nigeria

S/N	Ecotourism attractions/features/infrastructures	Location Coordinates Latitude	Longitude	Year of construction/ renovation	Construction material	Carrying capacity	Intensity of usage/patronage	Level of maintenance	Status of attractions
12	Gym	7.593528	4.980972	2010/2012	Cement/sand		Low	Moderate	Good condition
13	Supermarket	7.593528	4.980972	2010/2012	Glass/cement/block		Low	Low satisfactory	Good condition
14	Confluence of Warm and Cold	7.594444	4.981139	Over 700 yrs.			High	Moderate	Good condition
15	DJ spot	7.594444	4.981083	2010/2012	Raffia/wood		High	Low	Good condition
16	Chilling spot	7.593833	4.980944	2010/2012	Raffia/wood	15	Low	Low	Decapitated/good
17	Monkey spot	7.593972	4.981083	-	Metal/wood		High	Moderate	Good condition
18	Joint tree	7.594389	4.980833	Over 700 yrs.	Metal/wood		High	Low	Good condition
19	Zoo	7.592972	4.980778	1952	Metal		Low	Moderate	Good condition
20	Relaxation area	7.594528	4.980333	2010/2012	Wood	10	Low	Moderate	Good condition
21	Source of Warm Spring	7.594611	4.981028	Over 700 yrs.			High	Low	Good condition
22	Basketball court	7.5989611	4.981083	2010/2012	Concrete/metal		Low	Low	Dilapidated

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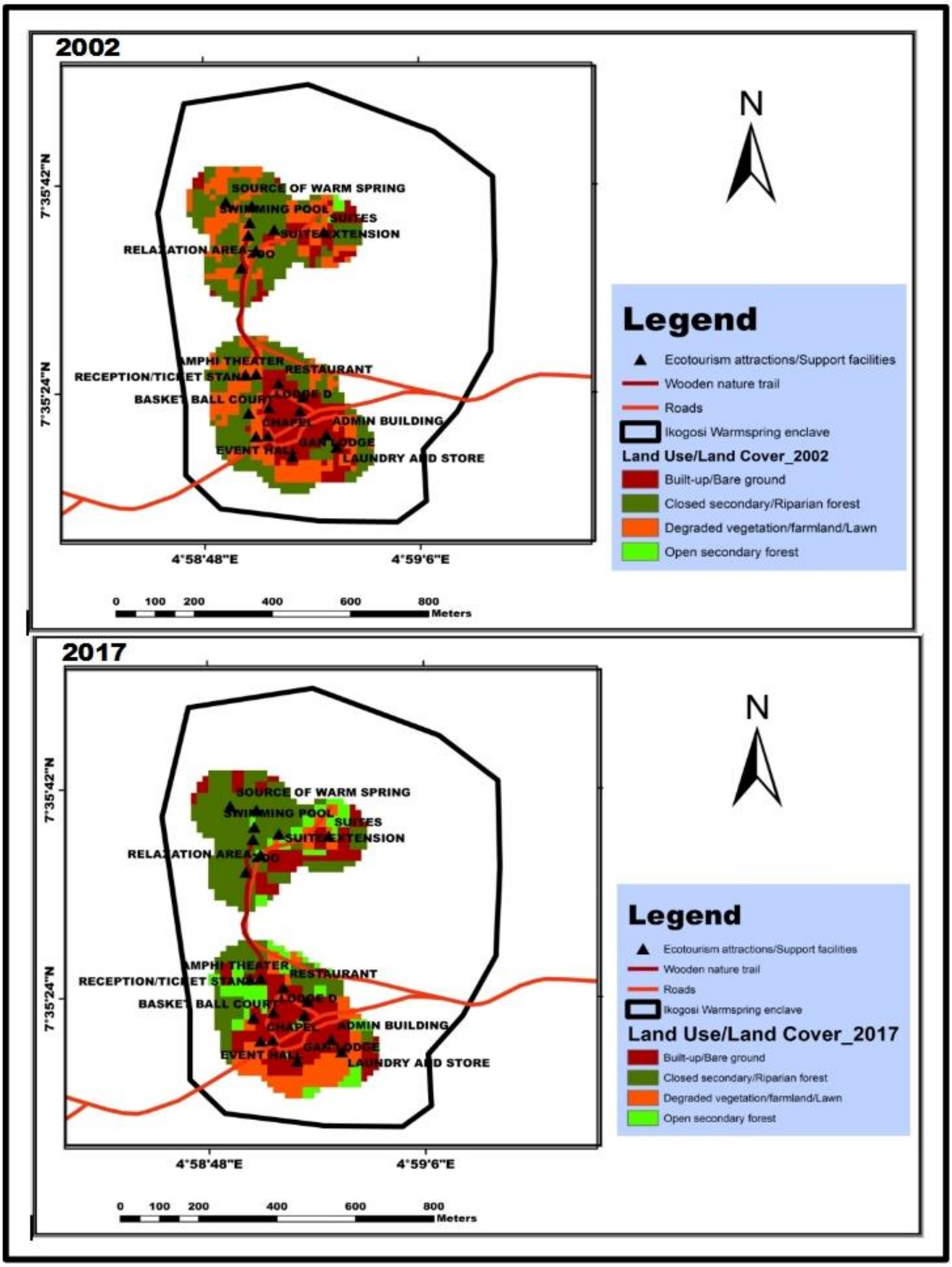

Figure 3: Land use/land cover around ecotourism attractions and support facilities of Ikogosi Warm spring Resorts, Ekiti State

Table 4: Attributes of the land use/land cover of Ikogosi Warm spring Resorts in 2002 and 2017

Land cover/land use classes	2002		2017	
	Area Cover (Hectares)	Proportion (%)	Area Cover (Hectares)	Proportion (%)
Built-up/Bare ground	118,279.53	14.45	179,225.09	21.89
Open secondary forest	55,302.45	6.75	127,985.67	15.63
Closed secondary/Riparian forest	430,681.95	52.61	448,062.72	54.73
Degraded vegetation/farmland/Lawn	214,438.08	26.19	63,428.53	7.75
Total	**818,702.00**	**100.00**	**818,702.00**	**100.00**

Table 5: Attributes and parameters of land use/land cover around supporting facilities in Ikogosi Warm Spring Resorts, Ekiti State

	2002		2017				
Land cover/land use classes	**Area Cover (Hectares)**	**Proportion (%)**	**Area Cover (Hectares)**	**Proportion (%)**	**Absolute change**	**Percentage change**	**Rate of change**
Built-up/Bare ground	13.57	22.62	18.83	31.39	60,945.56	51.53	3.44
Open secondary forest	0.34	0.57	7.92	13.20	72,683.22	131.43	8.76
Closed secondary/Riparian forest	28.11	46.84	24.37	40.62	17,380.77	4.04	0.27
Degraded vegetation/farmland/Lawn	17.98	29.97	8.88	14.80	-151,009.55	-70.42	-4.69
Total	60.00	100.00	60.00	100.00			

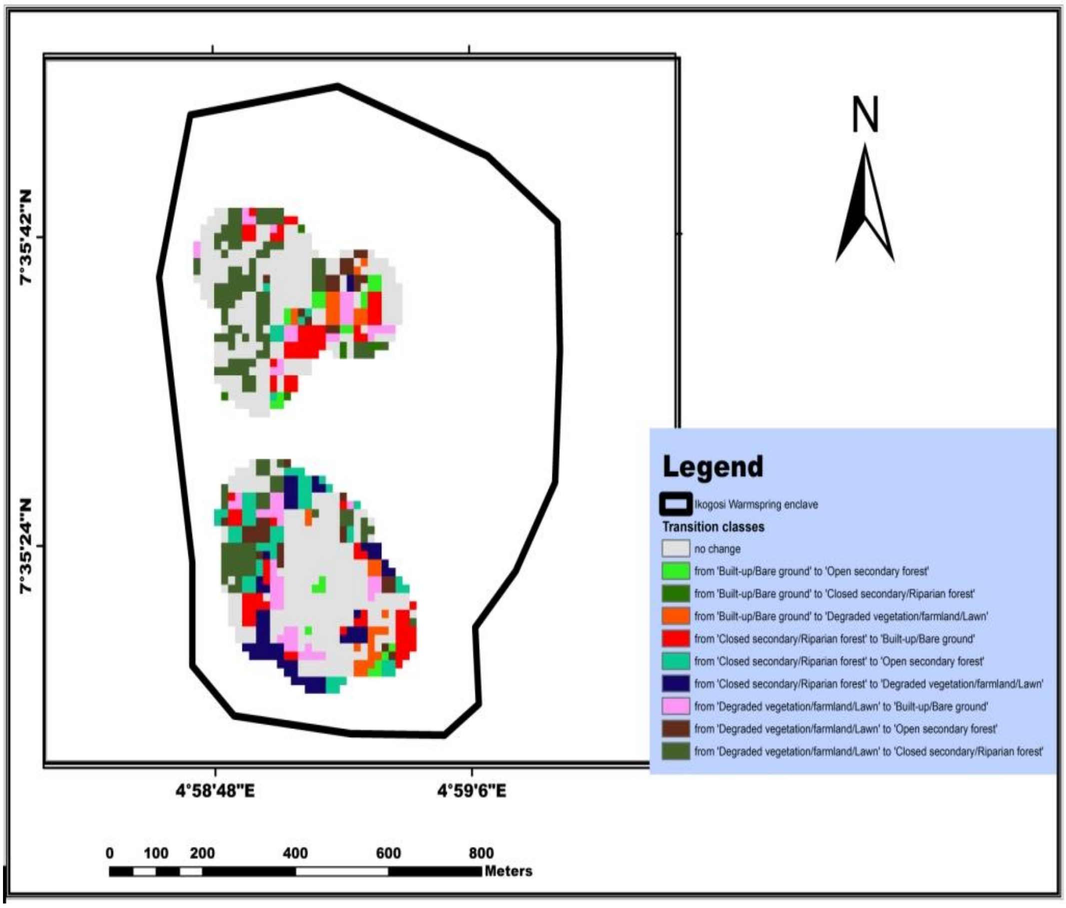

Figure 4: Transition matrix of the land use/land cover dynamics around ecotourism attractions and support facilities in Ikogosi Warm Spring Resort, Ekiti State

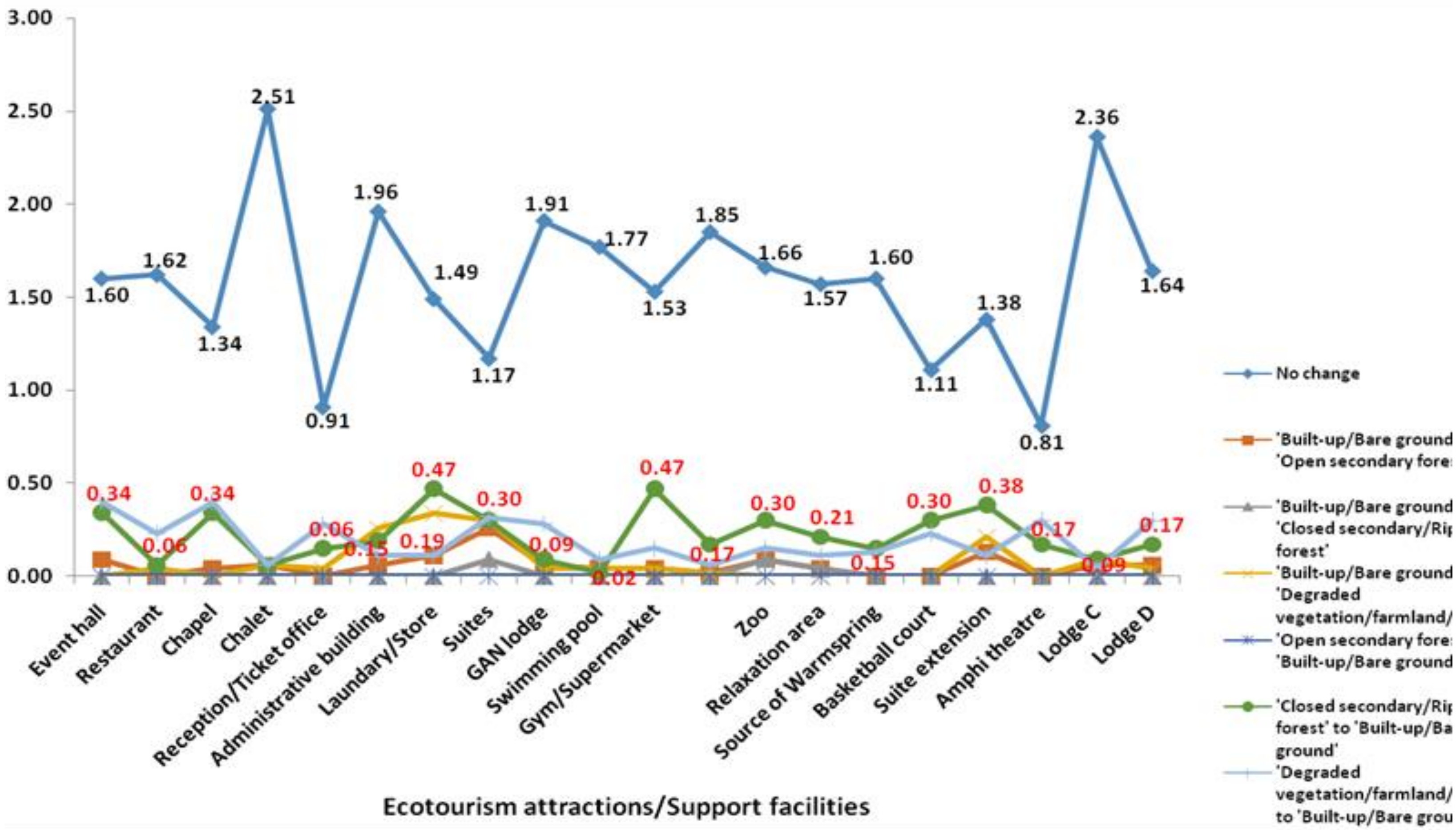

Figure 5: Transition matrix of the land use/land cover dynamics around each ecotourism attraction and support facility in Ikogosi Warm Spring Resort, Ekiti State

CONCLUSION

Ikogosi Warm Spring Resorts is blessed with enormous ecotourism attractions and support facilities. The improvement of the level of maintenance is germane to sustaining the current good state of these attractions and facilities. The general vegetation landscape is predominantly closed secondary/riparian forest with interspersed of open secondary forest, degraded vegetation and farmland. Thus, there was slight increment in the land mass occupied by the indicator of ecotourism's ecological impact (built-up areas/bare ground) within the time span of fifteen years most especially around some chalets. Moreover, the increases in land cover mass from degraded vegetation/farmland/lawn to closed secondary/riparian forest were evident, as a result of the intensified conservation practices.

However, the followings are recommended for Ikogosi Warm Spring Resorts: The management of Ikogosi Warm Spring Resorts should be proactive in working on the dilapidated facilities and further maintaining the ones in good conditions, caution should be taken by the resort's authority to lessen the increment in the land mass occupied by the indicator of ecotourism's ecological impact (built-up areas/bare ground) through adoption of sustainable approaches in the design and development of ecotourism attractions and support facilities, intensive marketing should be done to improve the low intensity of usage and patronage of some ecotourism attractions and support facilities, remote sensing and Geographic Information technology should be adapted into the ecological monitoring of the ecotourism site.

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