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## ANTHROPOGENIC FOOTPRINTS IN THE AMURUM FOREST RESERVE AND THE JOS WILDLIFE PARK, JOS PLATEAU STATE, NIGERIA

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### ABSTRACT

*Protected areas are constantly under anthropogenic threats especially those in close proximity to human settlements thus, it is highly important to regularly monitor human footprints (activities) within such areas in order to ensure the existence of the species they are meant to protect. Hence, this study identified and compared the anthropogenic footprints in the Jos Wildlife Park and Amurum Forest Reserve and sort linkages with some management strategies and challenges in the two reserves. Data was collected using a total of 40 quadrates of sizes 50 x 50 m placed systematically at a minimum distance of 50 m in each habitat. 20 of the quadrates were placed at the core and 20 at the edge of each study habitat. Anthropogenic activities were then examined in each habitat. Identified anthropogenic footprints include logging, firewood collection, mining, burning, residential encroachment, grazing, farmland, indiscriminate defeacation, waste dumping, road encroachment and play ground. Of these, mining, waste dumping and play ground were not recorded in the Amurum Forest Reserve. Anthropogenic footprints were significantly higher in terms of both type and level within the Jos Wildlife Park as compared to the Amurum Forest Reserve ( $P < 0.05$ ). Footprints were recorded more at the edge of the Amurum Forest reserve as compared to its core ( $P < 0.05$ ) but equally at both core and edge for the Jos Wildlife Park ( $P > 0.05$ ). Inadequate management strategies, funding, poor staff strength, and bureaucratic challenges were some of the possible reasons for the high level of anthropogenic activities observed in the Jos Wildlife Park.*

**Keywords:** Anthropogenic footprints, Amurum Forest Reserve, Jos Wildlife Park, Management strategies

### INTRODUCTION

Anthropogenic footprints are human impacts or activities on the environment. These activities include logging, agricultural practices, land development and usage, predation by domestic pets, and automobile traffic (Madu, 2008; Nitasha and Sanjiv, 2015; Kanianska, 2016). Such activities could impact on natural habitats and biodiversity directly or indirectly (Sahney *et al.*, 2010). Globally, these activities are gradually eroding wildlife habitats and threatening the existence of the species they contain (Foley *et al.*, 2005; Hansen *et al.*, 2010). They also make the achievement of any conservation goals in the areas where they are severe highly difficult to achieve. Increase in human population size over the years is regarded as the major cause for increased human activities across natural habitats (Slaughter, 2011; Kanianska,

2016). Human population growth has lead to expansion of agricultural activities which is the main causes of deforestation around the world with major forests giving way to plantations for oil palm, soy, rubber, coffee, tea, and rice among many other crops to meet human needs (Lal and Stewart 1990; Van der Warf, and Petit, 2002; Kyba *et al.*, 2014). Also, to enhance revenue in order to maintain economic growth for the increasing populations, exploration for minerals through mining activities has also been at its peak with consequences such as contamination of ground and surface water with chemicals, formation of sinkholes and erosion (Nuss and Eckelman, 2014; Nitasha and Sanjiv, 2015).

Also, the need for protein to meet human needs has also brought about widespread grazing activities including incursions into protected areas. This has

effects on plant species that are under conservation as the grazing animals tend to eat from quite a wide range of plant species that are present in the environment with attendant consequences on their dependent fauna (Kutt and Woinarski, 2007; Piana and Marsden, 2014). Other activities such as fuelwood collection, hunting and development of infrastructure have also been noted to be on the increase with wide range of effects on natural habitats (Du Plessis 1995; Bouget *et al.*, 2012; Jones *et al.*, 2014; Farris *et al.*, 2015).

Thus, Natural habitats are constantly under anthropogenic threats some of which go unnoticed or their severity are not well documented. Such threats could also be more severe where human settlements are in very close proximity to the protected areas. Therefore, any effort that tends to identify and measure the severity of human effects within protected areas would not only save species but may also arm management with useful tools for enlightenment and enforcement to ensure continued survival of species within the protected areas. Thus, this study was aimed at identifying and comparing anthropogenic footprints in the Amurum Forest Reserve and the Jos Wildlife Park and finding out any possible management strategies that may explain the differences if any. Both habitats were selected for this study mainly due to the increasing urbanization around them.

## MATERIALS AND METHODS

### Study Area

A large part of the vegetation cover of the Jos Plateau has been devastated by tin-mining activities, agriculture and unsustainable fuel wood collection which is facilitated by high human population (200-300 people per km) and poverty (Morgan, 1978; Alexander, 1990; Ndace and Danladi, 2012; Ideg, 2015). These has resulted in a few remaining patches of forest and woodland some of these include the Amurum Forest Reserve and the Jos Wildlife Park where this study was carried out.

### Amurum Forest Reserve

The Amurum Forest Reserve, is located in Laminga, Fobur district of Jos East Local Government Area, Plateau State, Nigeria (09°53' N and 08°59' E). The area is about 15 km North-east of Jos the capital of Plateau State, Nigeria and is located at an altitude of 1, 280 m above sea level. The area has three major habitat types namely; gallery forest often found along gullies with seasonal water flow, savannah scrub and rocky

outcrop (Ezealor, 2002). The reserve holds over 300 bird species which includes the endemic Rock Firefinch *Lagonosticta sanguinodorsalis* and its brood-parasite the Jos Plateau Indigobird *Vidua maryae* together with some other bird species that make the reserve an Important Bird Area (IBA) (Ezealor 2002).

### Jos Wildlife Park

The Jos Wildlife Park is located to the South West of Jos, Plateau State, Nigeria (9° 53'N, 8° 50'E). It was established in 1972 covering an area of approximately 8 km<sup>2</sup> and is characterized by hilly and rocky topography with seasonal streams, good savannah woodland and riparian forests. The area is an important habitat for birds and other wildlife (Ijeomah *et al.*, 2005; Turshak and Mwansat, 2011).

### Data collection

Data was collected in January 2017 using a series of 50 x 50 quadrates that were systematically positioned in the two study habitats. A total of 40 quadrates were placed in each habitat; 20 within the core and 20 quadrates at the edge of each protected area. Each quadrate was randomly stratified at a least distance of 50 m from one another in order to capture anthropogenic effects that are not wide spread within the areas. Quadrate observations were done between 0800 to 1300hrs each day. At each quadrate, presence or absence of various indices of anthropogenic factors were noted. These indices include fire wood collection, toileting activities (defecation), logging, waste dumping, agricultural activities, encroachment by human settlement and roads, habitat burning and mining.

### Assessment of Management Strategies and Challenges in the Amurum Forest Reserve and the Jos Wildlife Park

Eight management strategies and challenges were compared between the two study habitats. These include presence of volunteer guards/rangers, fire tracing, partnership with other organizations, funding, influx of human visitors, mobility, bureaucracy and biodiversity monitoring scheme. The management strategies and challenges were ranked on a scale of 1 to 3 (1 = poor performance, 2 = average and 3 = adequate/excellent). Assessment was based on information extracted from interview with selected staff, published materials and physical observations.

### Data analysis

Data was analysed using the SPSS statistical package version 17.0. Because data was of a count nature converted to percentage of total observation for each index of anthropogenic presence recorded

in each of the habitats, the Chi-square test of independence was used to test for differences in anthropogenic indices between the core and edge of each habitat and between the two study areas.

## RESULTS

### Data Description

Anthropogenic activities were observed in 15 of 40 quadrates surveyed in the Amurum Forest Reserve (representing 37.5 %) while 25 quadrates (i.e. 62.5 %) did not show any anthropogenic activity. However, all the 40 quadrates in the Jos Wildlife Park had anthropogenic activities observed within them. The observed differences was highly

significant between the two habitats (Chi Square test of independence,  $\chi = 33.513$ ,  $df = 1$ ,  $P < 0.001$ ).

### Anthropogenic Factors within the Amurum Forest Reserve and the Jos Wildlife Park

A total of 11 anthropogenic activities were recorded across the two study habitats. However, only 8 human activities were recorded at the Amurum Forest Reserve with mining, dumping of waste and presence of playground absent in the reserve. The Jos Wildlife Park however had all the 11 activities observed in the two habitats (Table 1).

**Table 1: checklist of Anthropogenic Activities recorded in the Amurum Forest Reserve and the Jos Wildlife Park as at January 2017 ( $\checkmark$  = Present; – = Absent).**

S/No.	Activities	Protected areas	
		Amurum Forest Reserve	Jos Wildlife Park
1.	Logging	$\checkmark$	$\checkmark$
2.	Fire wood collection	$\checkmark$	$\checkmark$
3.	Mining	–	$\checkmark$
4.	Burning	$\checkmark$	$\checkmark$
5.	Residential encroachment	$\checkmark$	$\checkmark$
6.	Grazing	$\checkmark$	$\checkmark$
7.	Farmland	$\checkmark$	$\checkmark$
8.	Human faeces	$\checkmark$	$\checkmark$
9.	Waste dump	–	$\checkmark$
10.	Road encroachment	$\checkmark$	$\checkmark$
11.	Play ground	–	$\checkmark$

### General Comparison of Anthropogenic Activities in the two Study Habitats

Generally, the Jos Wildlife Park significantly had more anthropogenic activities across all quadrates surveyed as compared to the Amurum Forest Reserve (Chi-square test of independence,  $\chi = 19.399$ ,  $df = 9$ ,  $P = 0.022$ ; Fig. 1); considering

activities separately, burning, logging and waste dumping are the top three activities occurring at the Jos Wildlife Park while generally, agricultural activities, grazing and poor toileting behaviour (human indiscriminate defecation) are the top three activities at the Amurum Forest Reserve.

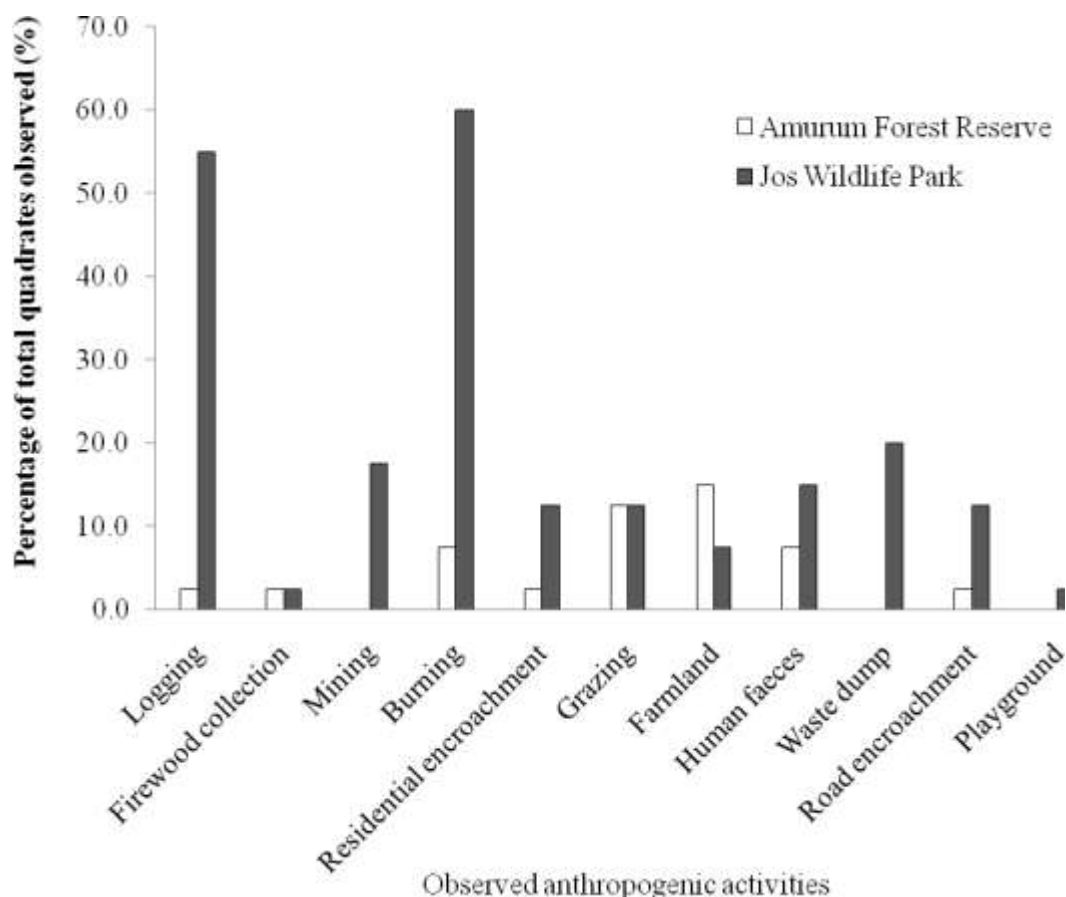


Figure 1: General comparison of Anthropogenic Activities between the Amurum Forest Reserve and the Jos Wildlife Park.

**Comparison of Anthropogenic Activities in the Core of the two Study Habitats**

Burning, firewood collection, logging, mining, grazing and indiscriminate defecation are the six factors recorded as indices of anthropogenic activities within the core of the two study habitats of these, only two activities namely firewood

collection and burning were recorded in the core of the Amurum Forest Reserve and these were seen in only one quadrate each. However, all the other six activities occurred in greater magnitude within the core of the Jos Wildlife Park and particularly habitat burning (Chi-square test of independence,  $\chi = 4.203$ ,  $df = 1$ ,  $P = 0.04$ ; Fig. 2).

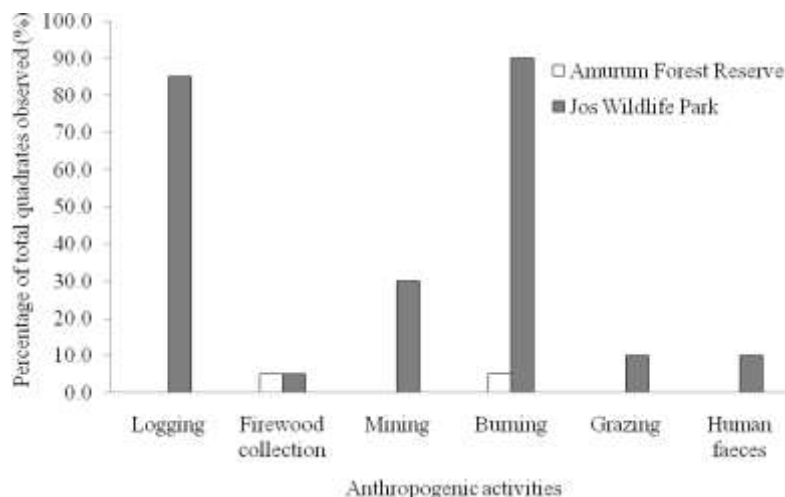


Figure 2: Comparison of anthropogenic activities occurring in the core of the two study habitats.

### Comparison of Anthropogenic Activities at the Edge of the two Study Habitats

Out of the 11 anthropogenic activities recorded, only firewood collection was not observed at the edges of both the Amurum Forest Reserve and the Jos Wildlife Park. Of these activities burning and

waste dumping were recorded the most at the edge of the Jos Wildlife Park while grazing and farmlands had higher records at the edge of Amurum Forest Reserve although this was not significant (Chi-square test of independence,  $\chi = 15.472$ ,  $df = 9$ ,  $P = 0.078$ ; Fig. 3).

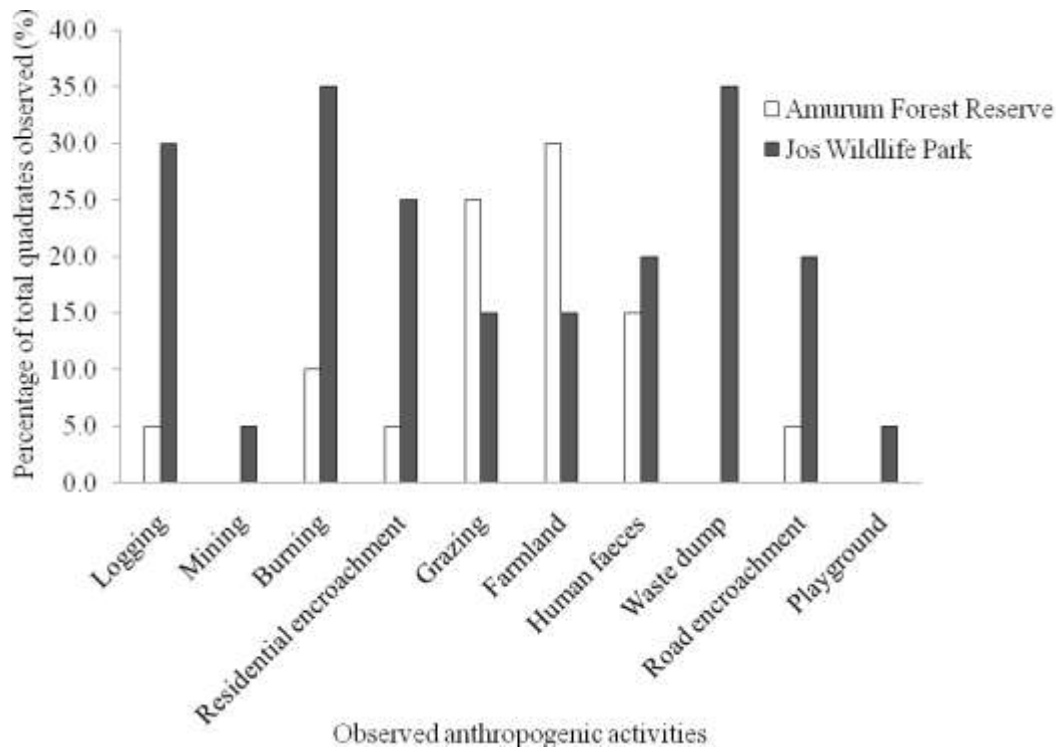


Figure 3: Comparison of anthropogenic activities at the edges of Amurum Forest Reserve and Jos Wildlife Park.

### Management Strategies for the Amurum Forest Reserve and the Jos Wildlife Park

Assesment of management strategies and challenges of the two reserves showed that the Amurum Forest Reserve rank better in terms of sufficient manpower overseeing the forest as either volunteer guards or rangers, the reserve also ranks better in terms of fire tracing efforts, partnership

with other conservation based organizations, funding, mobility and biodiversity monitoring efforts. However, in terms of influx of human visitors and bureaucracy, the Jos Wildlife Park was ranked highest compared to the Amurum Forest Reserve (Table 2).

Table 2: Comparison of the management strategies and challenges in the Amurum Forest Reserve and the Jos Wildlife Park as at January 2017 (Rank increases from 1 – 3; 1 = poor, 2 = average, 3 = adequate/excellent)

S/No.	Management strategies/challenges	Rank range	Amurum Forest Reserve	Jos Wildlife Park
1	Volunteer guards	1-3	3	1
2	Fire tracing	1-3	3	2
3	Partnership with other organizations	1-3	3	2
4	Funding	1-3	3	1
5	Human visitors	1-3	1	3
6	Mobility	1-3	3	1
7	Bureaucracy	1-3	1	3
8	Biodiversity monitoring scheme	1-3	3	1

## DISCUSSION

This study recorded the different anthropogenic footprints or activities within the Amurum Forest Reserve and the Jos Wildlife Park in relation to management strategies and challenges in the two protected habitats. Anthropogenic activities encountered include burning, farmlands, firewood collection, grazing, playground, residential and road encroachment, mining, indiscriminate defecation (human faeces), logging and waste dumping. While the management strategies and challenges assessed include adequacy of ranger/volunteer guards, fire tracing, influx of human visitors, biodiversity monitoring scheme, partnership with other organizations, funding, mobility and bureaucracy. Both reserves recorded anthropogenic activities at both their interior (core) and at the edge. However, the Amurum Forest Reserve had high anthropogenic activities occurring at its edge than its interior; only two anthropogenic activities (firewood collection and burning) were recorded in just two of the twenty quadrates surveyed in the core. The burning observed was also done officially as fire tracing activity to reduce severity of fire that may encroach into the reserve. On the other hand, the Jos Wildlife Park had very high anthropogenic activities at both its interior and edge. All the quadrates surveyed in this habitat had anthropogenic footprint.

There appears to be a strong link between the anthropogenic activities and the management strategies deployed in the two protected areas. For example, the Jos Wildlife Park ranked the poorest in all management strategies assessed and also had the worst management challenges. Strategies such

as the use of volunteer guards (or rangers) has been shown to be highly effective in management of natural resources; Volunteer guards takes responsibilities of guarding the forest, maintenance, law enforcement and provide wide range of informational service to visitors (US Rangers, 2004). In a situation where volunteer guards are lacking or are not sufficient as in the case of the Jos Wildlife Park, the park becomes vulnerable to human activities such as poaching, logging and several others. Based on observations during the study, logging of wood is carried out by the individuals from adjoining communities without the management even taking note. The logging of wood and fuelwood collection may be tied to high cost of alternative fuel (kerozene) for cooking as had been reported in previous studies (Sambo, 2005; Babanyara and Saleh, 2010).

Fire tracing is an activity that is carried out in a reserve which involves burning grasses and leave litter on footpaths in order to prevent accidental or deliberate fires from spreading widely in the reserve and causing serious damage to the ecosystem. Such fire tracing is done either immediately after the raining season, deep into the dry season or late into the dry season. While the Amurum Forest Reserve appears to have good fire management, this was however not the case for the Jos Wildlife Park and may have been the reason for the widespread burning observed in the Park.

A reserve needs adequate funding to carry out conservation activities. If there is poor funding, monitoring and habitat maintenance may suffer. Perhaps this explains why mining activities where

taking place within the Jos Wildlife Park even within the core of the reserve with little or no attention by the managers.

Establishing partnership/collaboration with other organizations increases the funding strength of an organization and as well sharpens the expertise of its local staff as it provides opportunities to share experiences. This is perhaps one of the advantages that the Amurum Forest Reserve seems to have gained from its numerous partnerships which include collaboration with the Swedish Ornithological Society which has funded fire tracing activities in the past as observed on bill boards in the Reserve. Collaboration with other Institutions such as the Edward Grey Institute of Ecology, University of Oxford, Lund University, Sweden, University of Cape Town, South Africa and a host of others. These appear to have also impacted on local manpower as some current staff have undergone various training including doctoral studies in these Institutions.

Presence of human visitors to the reserve is an avenue to raise funds and support conservation activities. The Jos Wildlife Park has more human visitors compared to the Amurum Forest Reserve this is because of its large size and having facilities that encourages social activities such as weddings, birthday parties e.t.c whereas the Amurum Forest Reserve's visitors are mostly researchers and students on educational trips. This high influx of visitors to the Jos Wildlife Park coupled with inadequate manpower in terms of rangers and close proximity to adjoining communities may have contributed to the widespread anthropogenic activities noticed in the Park particularly unregulated defecation and waste dumping within the reserve.

Mobility in terms of vehicles helps to make work much easier for both visitors and staff of the reserve in order to conduct research or for field trips. The Jos Wildlife Park has no active operational vehicle as at the time of this survey. However, the Amurum Forest Reserve has adequate mobility making logistics much easier.

Bureaucracy is the administrative system which is governing an organization (David, 2010; Weber, 2015). The Jos Wildlife Park has several administrative layers which may lead to slow decision making concerning the park while the Amurum Forest Reserve has a Director who is

empowered to take immediate decisions on what happens in the reserve. The elimination of unnecessary bureaucracy is a major way to improve managerial strategies (Wren and Bedeian, 2009) this could be one of the reasons for the conservation successes observed in the Amurum Forest Reserve.

Biodiversity monitoring scheme is an exercise that is carried out in an area to know the status of each species present in the locality from time to time. The Amurum Forest Reserve has very effective and frequent monitoring schemes that monitors both biodiversity and species survival particularly through its Constant Effort Scheme (CES). Such scheme helps to quickly pinpoint any extinction trends which could be further verified and prevented. This scheme is however lacking in the Jos Wildlife Park.

## CONCLUSION

The result from this study showed significant level of anthropogenic activities (footprints) particularly in the Jos Wildlife Park. Similarly, the level of anthropogenic activities differ between the core of the reserve and the edge particularly for the Amurum Forest Reserve which had most activities at the edge with very minimal footprint at the core. These observed differences are strongly linked to the management strategies and challenges assessed in the two protected areas; the Jos Wildlife Park which had the most anthropogenic footprints, appeared to perform poorly in comparison to the Amurum Forest Reserve in terms of manpower, mobility, funding, partnership with other organizations, fire management, bureaucracy, influx of visitors and biodiversity monitoring.

## Recommendations

Based on the findings of this research, the following recommendations are made;

1. The State Government should employ more skilled workers for the Jos Wildlife Park to ensure effective monitoring and conservation of the area
2. Management strategies such as fire tracing, biodiversity monitoring, partnership with other conservation based organizations/Institutions and adequate funding should be improved for the Jos Wildlife Park.
3. There is also the need to create awareness in the immediate communities of the two protected areas in order to halt the anthropogenic activities observed.

## REFERENCES

- Alexander, M.J. (1990). Reclamation after tin mining on the Jos Plateau Nigeria. *The Geographical Journal* 156 (1): 44 – 50.
- Babanyara, Y.Y. and Saleh, U.F. (2010). Urbanisation and the Choice of Fuel Wood as a Source of Energy in Nigeria. *Journal of Human Ecology*, 31 (1): 19 – 26.
- Bouget, C. Lassauce, A. and Jonsell, M. (2012). Effects of fuelwood harvesting on biodiversity - a review focused on the situation in Europe. *Canadian Journal of Forest Research*, 42 (8): 1421-1432.
- David M. (2010). Gates Criticizes Bloated Military Bureaucracy. CBS News.
- Ezealor, A.U., (Ed.) (2002). Critical sites for biodiversity conservation in Nigeria. Nigerian Conservation Foundation: Lagos, Nigeria, 65 pp.
- Farris Z.J.; Golden, C.D.; Karpanty, S.; Murphy, A.; Stauffer, D.; Ratelolahy, F. Andrianjakarivelo, V.; Holmes, C.M. and Kelly M.J. (2015). Hunting, Exotic Carnivores, and Habitat Loss: Anthropogenic Effects on a Native Carnivore Community, Madagascar. *PLoS ONE* 10 (9): e0136456. <https://doi.org/10.1371/journal.pone.0136456>.
- Foley, J.A.; DeFries, R.S.; Asner, G.P.; Barford, C.; Bonana, G.; Carpenter, S.R.; Chapin, F.S. et al. (2005). Global consequences of land use. *Science*, 80 (309): 570–574.
- Hansen, M.C.; Stehman, S.V. and Potapov, P.V. (2010). Quantification of global gross forest cover loss. *Proceedings of the National Academy of Sciences of the United States America*, 107: 8650–8655.
- Idegu, Y.A. (2015). Why the deserts keep encroaching. <http://thenationonlineng.net/why-the-desert-keeps-encroaching/>
- Ijeomah, H.M.; Ayodele, I.A.; Alarape, A.A. and Edet, D.I. (2005). Contributions of Jos Wildlife Park towards conservation education in Plateau State, *Journal of Environmental Extension* 5: 70-76.
- Jones, I.L.; Bull, J.W.; Milner-Gulland, E.J.; Esipov, A.V. and Suttle, K.B. (2014). Quantifying habitat impacts of natural gas infrastructure to facilitate biodiversity offsetting. *Ecology and Evolution* 4 (1): 79-90.
- Kanianska, R. (2016). Agriculture and Its Impact on Land-Use, Environment, and Ecosystem Services, *Landscape Ecology - The Influences of Land Use and Anthropogenic Impacts of Landscape Creation*, Dr. Amjad Almusaed (Ed.), InTech, DOI: 10.5772/63719. Available from: <https://www.intechopen.com/books/landscape-ecology-the-influences-of-land-use-and-anthropogenic-impacts-of-landscape-creation/agriculture-and-its-impact-on-land-use-environment-and-ecosystem-services>.
- Kutt, A.S. and Woinarski, J.C. (2007). The effect of grazing and fire on vegetation and the vertebrate assemblage in a tropical savanna woodland in north-eastern Australia. *Journal of Tropical Ecology* 23: 95–106.
- Kyba, C.; Stefanie, G.; Kuechly, H.; de Miguel, A.; Zamorano, J.; Fischer, J.; Hölker, F. (2014). High-Resolution Imagery of Earth at Night: New Sources, Opportunities and Challenges. *Remote Sensing*, 7 (1): 1–23.
- Lal, R. and Stewart, B. A. (1990). Soil degradation. Springer-Verlag, New York.
- Madu, I.A. (2008). The Impacts of anthropogenic factors on the environment in Nigeria. *Journal of Environmental Management* 90 (3): 1422 – 1426.
- Morgan, W.B. (1978). Development and the fuelwood situation in Nigeria. *Geographical Journal* 2 (5): 437-442.
- Morné A. Du Plessis (1995). The effects of fuelwood removal on the diversity of some cavity-using birds and mammals in South Africa. *Biological Conservation* 74: 77-82.
- Ndace J.S. and Danladi, M.H. (2012). Impacts of Derived Tin Mining Activities on Landuse/Landcover in Bukuru, Plateau State, Nigeria. *Journal of Sustainable Development* 5 (5): 90-100.
- Nitasha, K. and Sanjiv, T. (2015). Influences of natural and anthropogenic factors on surface and groundwater quality in rural and urban areas. *Frontiers in Life Science* 8 (1): 23-39.



- Nuss, P. and Eckelman, M.J. (2014). LifeCycle Assessment of Metals: A Scientific Synthesis. *PLoS ONE*. 9 (7).
- Piana, R.P. and Marsden, S.J. (2014). Impacts of cattle grazing on forest structure and raptor distribution within a neotropical protected area. *Biodiversity and Conservation* 23 (3): 559-572.
- Sahney, S., Benton, M.J. and Ferry, P.A. (2010). Links between global taxonomic diversity, ecological diversity and the expansion of vertebrates on land. *Biology Letters*, 6 (4): 544–547
- Sambo, A.S. (2003). Energy options for sustainable national development: Resources, issues, and the position of renewable energy technologies. *Solar and Wind Technology* 12 (3): 25-60.
- Slaughter, R.A. (2011). Welcome to the anthropocene. *Futures* 44 (2): 19–26.
- Turshak, L.G. and Mwansat, G.S. (2011). Insect diet of some afro-tropical insectivorous passerines at the Jos Wildlife Park, Nigeria. *Science World Journal* 6(4): 1-4.
- Van der Warf, H. and Petit, J. (2002). Evaluation of the environmental impact of agriculture at the farm level: a comparison and analysis of 12 indicator-based methods. *Agriculture, Ecosystems and Environment* 93 (1–3): 131–145.
- Weber, M. (2015). "Bureaucracy" in Weber's Rationalism and Modern Society, translated and edited by Tony Waters and Dagmar Waters, Palgrave-Macmillan. pp114
- Wren, D.A. and Bedeian, A.G. (2009). The evolution of management thought (6<sup>th</sup> Ed.). Hoboken, N.J.: Wiley.