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Effects of Infrastructure Development on African Cape buffalo Behaviour: A Case Study of Lake Nakuru National Park, Nakuru County, Kenya

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Abstract

The study's purpose was to assess the impacts of infrastructure development on African Cape buffalo behaviour in Lake Nakuru National Park. Descriptive survey design was used in this research since it allowed the study of African Cape buffalo without affecting their normal behaviour. The target population size was 215,000 people from which a sample size of 138 respondents was derived using Brickman's formulae. Key Informant Interviews (KIIs), questionnaires and field observation were used to collect primary data. Statistical Package for social science (SPSS) version 25 was used in data analysis. Descriptive analysis is presented using tables, frequencies and percentages while inferential statistics was done using regression model. Secondary data collected through a review of government documents and environmental journals was further used to enrich the results. It was established that infrastructure development exists in Lake Nakuru National Park, and it affects the African Cape buffalo behaviour. The study further indicated that the conservation policies aided in conserving the African Cape buffalo. Recommendations given are useful in environmental policy formulation for sustainable development of protected areas in both the county level and the national level.

Key Terms: Effects, Infrastructural development, African Cape buffalo, Behaviour.

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Introduction

Infrastructure is a term used for the underlying physical systems of a society. It is inclusive of transportation, communication, sewage, water, water points, electric fence, viewing points and electricity structures. Infrastructural development, therefore, is the construction and improving the foundational services in a given society. Infrastructure is an essential development in any sector (Torres, Jaeger, & Alonso, 2016). Physical development provides the underpinnings of modern society. Human population growth and development heavily depend on infrastructural development, making it nearly impossible to neglect it. According to Torres et al. (2016), recreation and tourism in protected areas are important economic activities which necessitate the availability of infrastructural development. Despite the enormous potential of the protected area to generate income through proper infrastructural development at tour destinations, there are several negative impacts on the wild game (Said et al., 2016). For example, construction of roads in a protected area fragments the habitat for the African Cape buffalo and other wildlife species. Additionally, in adverse cases, it may lead to both fauna and flora loss.

Environmental losses arise when the ecological aspects are not considered during the design, planning, and construction phase of the development activity (Said et al., 2016). It is vital for the government, conservation agencies, and development sector to consult each other at every stage to align the development activity to the environmental protection and conservation laws. Nevertheless, this has not been affected in most of the countries, especially the third world countries (Sindiga, 2018). As a result, they continue to undertake development activities on the verge of attaining development standards at the expense of wildlife protection.

LITERATURE REVIEW

The USA is one of the world's developed countries. Infrastructural development, therefore, occupies large landmasses in the USA. As opposed to the pre-industrial era, the wild game habitat is now reduced and fragmented (Said et al., 2016). Habitat loss and fragmentation have adversely affected several native life species, especially the endangered ones. Twenty-nine species and sub-species, which are official state symbols of the 24 United States, are at risk of extinction. The bison is only one of the iconic threatened species, and other species include; Florida panthers and manatees. The Bison which is the same family with African buffaloes, for instance, have generally decreased in numbers. Since they are heavy grassers, infrastructural development affects them as they cause land-use change (Said et al., 2016). Areas which are supposed to be feeding grounds for Bison are occupied by infrastructure. The bison population that survives today occupies a space less than 1 per cent. Some of them are not entirely 'bison' as they have interbred with cattle.

In East Asia, the quest for development has resulted in tremendous infrastructural developments (Hitchcock, King, & Parnwell, 2018). Infrastructural development is owed to improved technology and innovative citizens. The countries have fewer land masses since the majorities are surrounded by water. Therefore, they seek to maximize the little land available to the vast population present. As a result, the countries have recorded enormous economic growth evident through the high net domestic income. Protected areas, however, face many challenges as infrastructural development affects their ecosystems by pollution, habitat fragmentation, and niche losses. Species such as the giant panda, buffaloes, Asian tiger, Indian rhinoceros, and the Asian elephants have decreased in numbers since the advent of industrialization, which was marked by increased infrastructural development. According to Hitchcock et al. (2018), human activities in this region have destroyed habitats and disrupt the wild game food chain. The distribution of habitats and food chain over time has increased the number of threatened and endangered species in the protected areas.

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In Africa, it is estimated that by 2030, the infrastructural and industrial activity will disrupt about 60 per cent of the wildlife ranges (Laurance, Campbell, Alamgir, & Mahmoud, 2017). About 30 of development corridors in sub-Sahara Africa will transverse over four hundred protected areas. Therefore, approximately 1,800 nature reserves will be degraded, leading to a loss of connectivity and ecological integrity. In the quest for development, the African countries have started implementing SDG number 9 strategies. According to Laurance et al. (2017), without proper ways of mitigating the effects, natural habitats get disturbed, affecting the plant and animals species in the protected areas. For example, in Africa, the high demand for energy since the year 2014 has led to the creation of thousands of dams across vital ecosystems resulting in habitat fragmentation and loss.

The Kenyan government has also embarked on the ambition to open up its regions through improved infrastructural development (Kochore, 2016). The effects of the infrastructural development are being experienced in Nairobi national park due to the construction of the northern bypass and other infrastructural amenities within the park and around it. The region is a migration corridor for wildlife migration and has raised concerns over the years due to the number of human-wildlife conflicts registered (Ogega, Wanjohi, & Mbugua, 2019). Apart from road constructions near and within the protected areas, there are also efforts to construct various facilities within the region. For instance, through favourable laws and regulations, it has been possible for investors to build hotels, accommodation facilities, and camping sites within the protected areas. The Kenya wildlife (conservation and management) Act Number 47 of 2013 is the main regulating framework of the wildlife (Njoroge, 2017).

Infrastructure developments such as roads, lodges, campsites, electric perimeter fence, sewage, airstrip, water points, viewing points and ranger bases exist in Lake Nakuru National Park. This causes land-use change which directly affects the African Cape buffalo behaviour (Landman, Kloppers, & Kerley, 2018). Ecological effects caused by the existence of infrastructure development include; habitat loss and fragmentation. This affects the African Cape buffalo home ranges exposing them to, physical disturbance, stress and diseases. Home ranges changes also increase the mortality rate of the African Cape buffalo (Ariya, Sitati, & Wishitemi, 2017). The objective of the study was to assess the effects of infrastructure development on the African Cape buffalo. Lake Nakuru National Park is an enclosed small protected area with an area of 188km^2. However, there are numerous browsers, both small and big in the park, amongst them being 3,500 African Cape buffalo in the park. Therefore, resource competition amongst the browsers, especially for water and browse is high (Dean, Seymour, & Joseph, 2018). Moreover, the small park area automatically increases the contact between infrastructure and the African Cape buffalo. Therefore, African Cape buffalo becomes vulnerable to the close proximity of infrastructure developments.

METHODOLOGY

The instruments used to collect qualitative and quantitative data were; Key Informant Interviews, questionnaires, literature review, and field observation. The target persons for KIIs included; county government official, private investor, and groups/agencies relating to the environment, like, the National Environment Management Authority (NEMA). Random purposive sampling was used to select interviewees who provided data and recommendation measures for peaceful co-existence between infrastructure and wild game. A wide variety of documents, including journals and newspapers, were reviewed and synthesized to source information relevant to the study. The county government documents relating to Lake Nakuru National Park were reviewed together with other sources. Data, information, and photographs retrieved from the literature review was analysed, and the results presented descriptively. Field observation within the park was carried out and photographs taken during the field visits. GPS

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coordinates of infrastructure development were acquired during the field visit, which helped in maps generation using ArcGIS. Questionnaires were issued to the local community, KWS officials, KWS rangers, tour guides and research personnel, capturing the crucial aspects of the study. One hundred thirty-eight questionnaires were issued to the potential respondents selected randomly to obtain primary data. The questionnaires were sorted, and the data edited and coded before being fed into the Statistical Package for Social Science (SPSS) version 25 for analysis. The research utilized both quantitative and qualitative data which were analysed descriptively. Regression analysis was used to show the causal relationship between infrastructure development and the African Cape buffalo behaviour, which were the research variables.

RESULTS AND FINDINGS

Infrastructure Development in Lake Nakuru National Park

Through field observation, it was proved that infrastructure exists in Lake Nakuru National Park. The infrastructure developments that were identified are; roads, electric perimeter fence, sewage, hotels/lodges, campsites, residential houses (for game wardens), viewing points and water troughs and dams. Eight hotels/lodges were identified namely; Sarova lion hill, Lake Nakuru Lodge, Nakuru Sopa, the Cliff, Flamingo tented camp, WCK guest house, WCK hostels and Naishi guest house. The electric perimeter fence measures 78km as it encloses the park completely. Water troughs are 14 in number while the water dams are 11. However, only five are serviceable. The sewage has been fenced off the park to prevent African Cape buffalo and other wild game from wallowing in the sewage. Roads are un-tarmacked, but they are well serviced all year round. Three viewing points were identified namely; Baboon cliff, lion hill and Out of Africa. Seven campsites were also identified and mapped. Ranger bases were also noted, their headquarters being in Naishi airstrip. Figure 1 and 2 are maps showing the infrastructure development in Lake Nakuru National Park.

Torres et al., (2016) noted that infrastructure opens up areas long kept pristine for African Cape buffalo and other wild game. Touristic activities necessitate the erection of infrastructure development in protected areas. The study findings were consistent with the above statement, as it revealed that there are numerous infrastructure development in Lake Nakuru National Park. However, it was noted that infrastructure resulted in numerous dis-conservancy areas which alter the behaviour of the African Cape buffalo.

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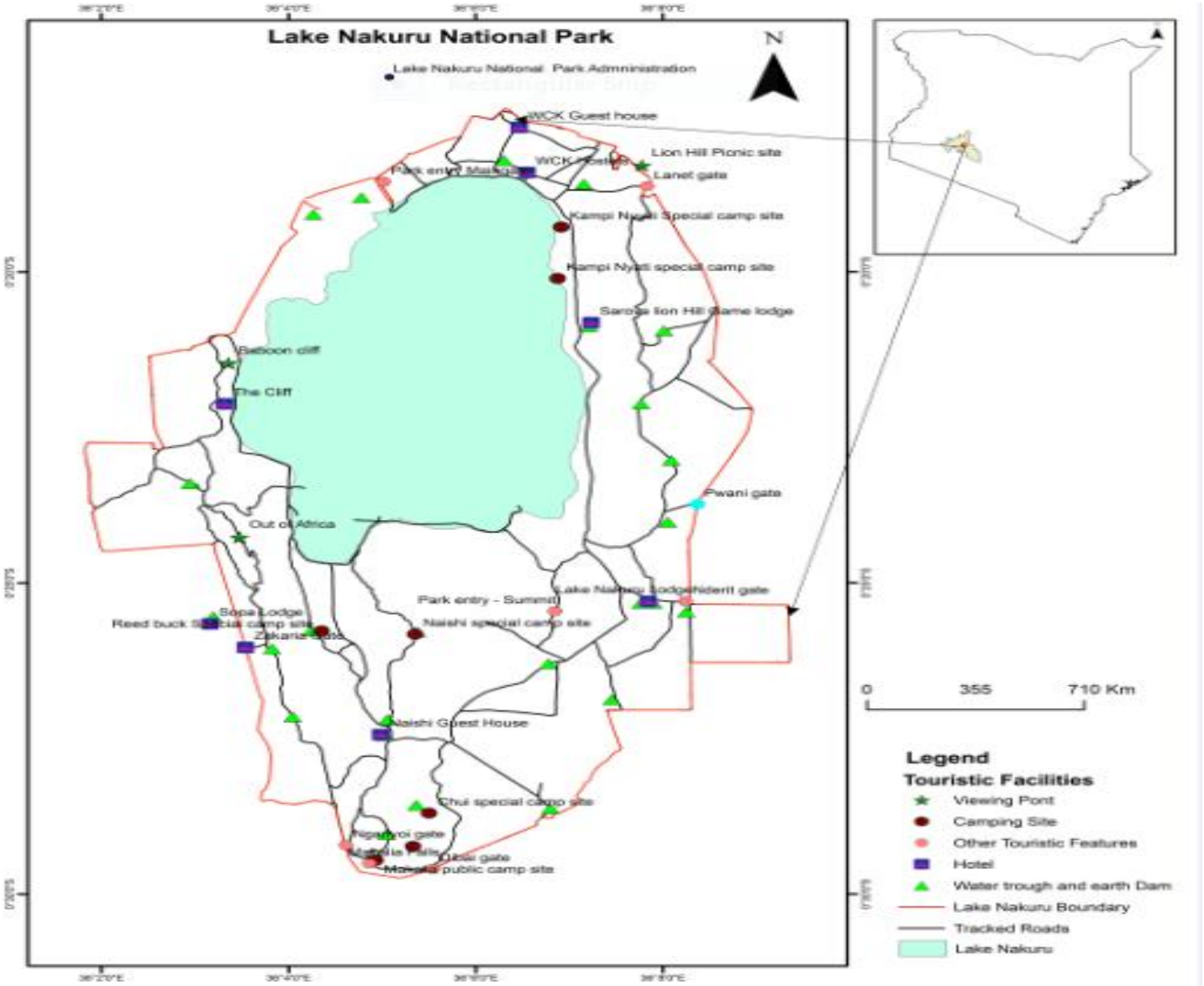

Figure 1: A Map Showing Infrastructure Development in Lake Nakuru National Park

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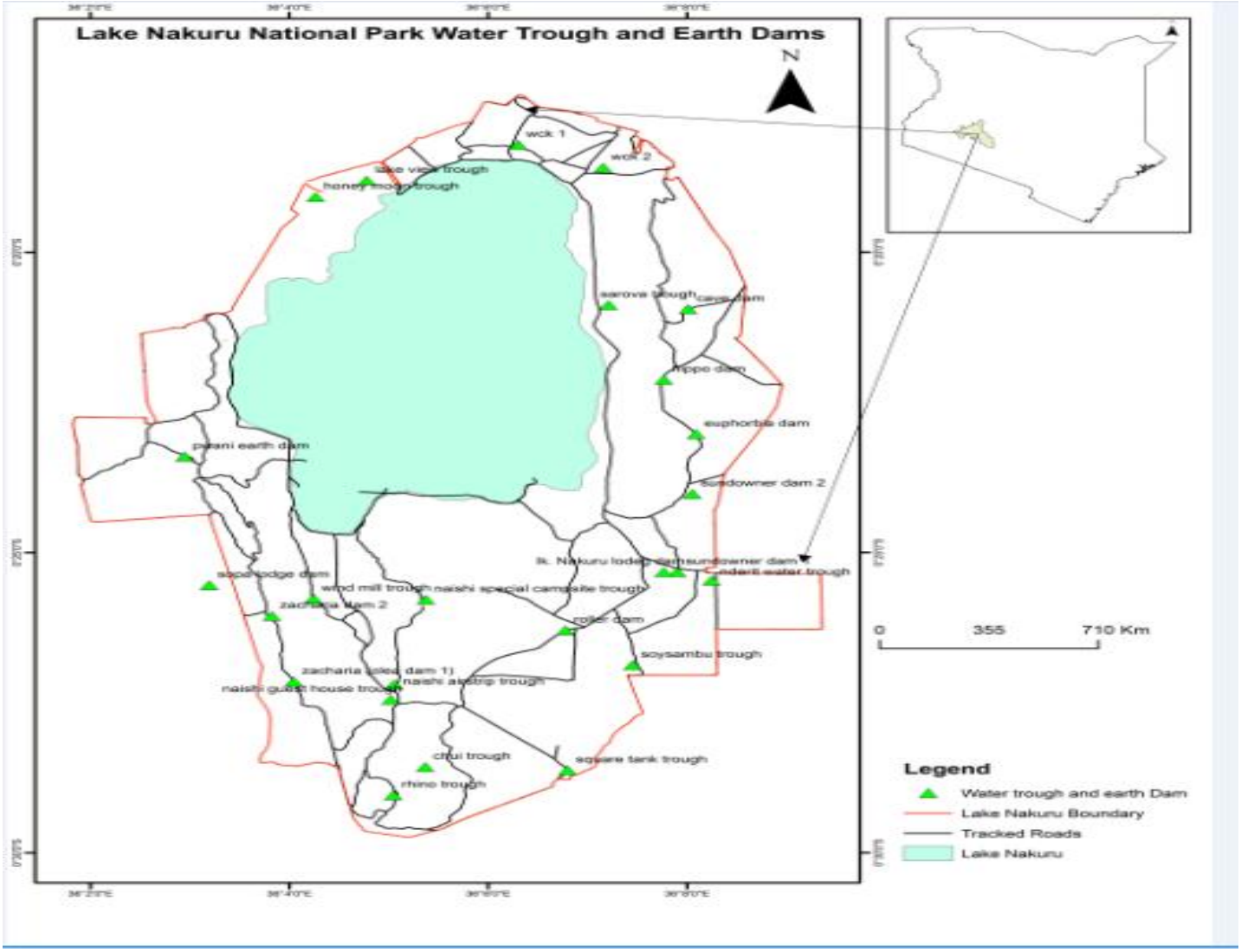

Figure 2: A Map Showing Water Troughs and Dams in Lake Nakuru National Park

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Effects of infrastructure development on the African Cape Buffalo

It was established that infrastructure development exposes the African Cape buffalo to new ecosystem settings, therefore, limiting their movement and migration, feeding, breeding, territory marking and defence. This is because a new ecosystem with varied characteristics is created, which ultimately affects the African Cape buffalo home ranges. Lee (2014), estimated that infrastructure in the protected areas directly affects unruly wild game behaviour 19 times larger than the 1% land surface that is physically occupied. This is consistent with the study findings, which implied that African Cape buffalo is affected in a great extent by the presence of infrastructural

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development in the park, which is an enclosed protected area.

It was further asserted that, for survival, the African Cape buffalo needs food, shelter and reproduction to continue existing. The infrastructural development present in the park affects these three key elements necessary for the African Cape buffalo survival. At the point where all the three elements are at their maximum, favourable conditions are availed to the African Cape buffalo marking the highest productivity. This point is known as the optimum. However, infrastructure development presence in the park affects the optimum. Below is an illustration of the optimum level.

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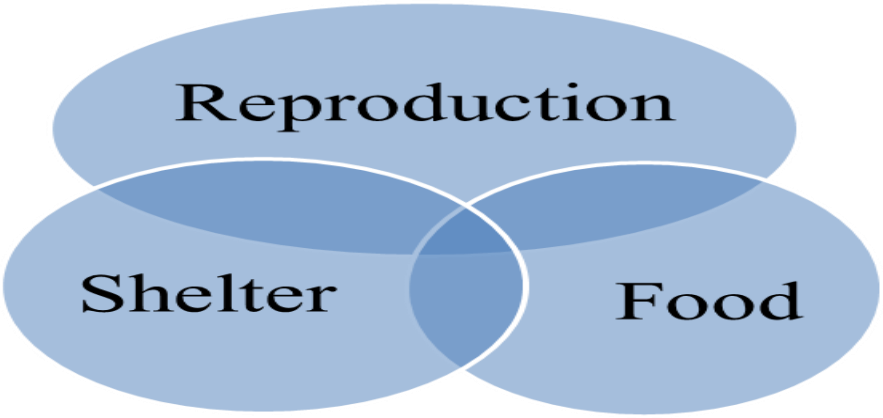

Figure 3: Optimum Level for the African Cape Buffalo survival

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Affected African Cape buffalo Behaviour by Infrastructural Development

The study sought to establish the most affected African buffalo behaviour by infrastructure development in Lake Nakuru National Park. Results summary are shown below in table 1.

Table 1: Affected African Cape buffalo behaviour

	Frequency	Per cent
Breeding	20	16.4
Feeding	51	41.8
Migration & Movement	27	22.1
Territory Marking	14	11.5
Defence	10	8.2
Total	122	100.0

The results on Table 1 indicate that most respondents held the opinion that feeding was most affected with a percentage of 42%, 22% of the respondents indicated that migration and movement was most affected, 16% of the respondents held the opinion that breeding was most affected, 12% of the respondents indicated that territory marking was the most affected while the remaining 8% of the respondents held the opinion that defence of the African buffalo behaviour was affected most by infrastructural development.

The study, therefore, denoted that, home ranges are affected by infrastructure development which affects the availability of limited resources such as water and pasture, therefore, affecting feeding. This is consistent with Mayor, Schneider, Schaefer, and Mahoney (2009) findings that often at times animals need to share the limited resources available such as water and browse where space is limited

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arising to conflicts or malnutrition when the resources are depleted.

African Buffalo Behavioural Change Caused by Existence of Infrastructure Developments

The study realized the objective further by asking the respondent's agreement on the following statements relating to the effects on infrastructure development on the African Cape buffalo. The status of effects on this variable was rated on a 5 point Likert scale. The responses were analysed using frequencies, percentages, mean and standard deviation. The results are presented in Table 2.

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Table 2: African Buffalo Behavioural Change Caused by Existence of Infrastructure Developments

Measurable indicators N=122	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Standard Deviation
Migration & movement	1(0.8%)	8(6.6%)	26(21.3%)	70(57.4%)	17(13.9%)	3.77	0.801
Breeding	2(1.6%)	4(3.3%)	30(24.6%)	61(50%)	25(20.5%)	3.84	0.843
Territory marking	4(3.3%)	8(6.6%)	49(40.2%)	43(35.2%)	18(14.8%)	3.52	0.938
Feeding	3(2.5%)	7(5.7%)	8(6.6%)	47(38.5%)	57(46.7%)	4.21	0.973
Defence	5(4.1%)	29(23.8%)	48(39.3%)	21(17.2%	19(15.6%)	3.16	0.086

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The results on table 2, indicate that majority of the respondents 71%, were in agreement that infrastructural development has significant effects on African Cape buffalo migration and movement (mean=3.77, SD=0.801). There was agreement among most respondents, 70% that infrastructural development has significant effects on African Cape buffalo breeding (mean=3.84, SD=0.843). According to a fair majority of the respondents 50%, infrastructural development has significant effects on African Cape buffalo territory marking (mean= 3.52, SD=0.938) while 40% of the respondents showed neutrality in opinion on this statement. A larger majority of the respondents, 85%, were in agreement that infrastructural development has significant effects on African Cape buffalo feeding (mean=4.21, SD=0.973). In addition, 39% of the respondents held the neutral opinion that infrastructural development has significant effects on African Cape buffalo defence (mean=3.16, SD= 1.086), 33% were in agreement while 28% of the respondents were in disagreement with this statement. All the responses had standard deviation values less than 1, which implies that there was no disparity in opinions among the respondents on infrastructural development statements.

The study further sourced the degree to which infrastructure development affected the African Cape buffalo. Discussion on the effects of infrastructure development on African Cape buffalo feeding, migration/movement, breeding, defence and territory marking are described below;

On feeding, infrastructure developments reduce grazing fields of the African Cape buffalo. The sewage line that crosses the park to the main sewage often contaminates available browse when they burst. This reduces the available browse for the African Cape buffalo due to contamination. On coming into contact with the African Cape buffalo, the effluent infests the buffalos with worms which alters their health. Additionally, the sewage system

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is not efficient in purifying the waste; however, the by-products of the purifying process are released to Lake Nakuru. This contaminates the lake which serves as the resting and bathing place for the African Cape buffalo.

Concerning migration and movement, the electric fence which encloses the park limits the movement of the African Cape buffalo to the neighbouring ecosystem. The electric fence erected around the park confides the Buffalos in the park which limits their feeding grounds and territories. Confiding the African cape buffalos in the park makes them compete with other browsers and grazers such as zebras in the park for the food available.

For breeding, infrastructure development interferes with the African Cape Buffalo breeding in varied ways. For instance, the utilization of infrastructure, such as roads disrupts the breeding activities of the African Cape buffalo. This is due to the noises produced as these infrastructures are used. The noise pollution disrupts the mating buffalos as they become tensed and alert for defence purposes. However, this does not affect the quantitative results of breeding. This is evident by the ever-growing number of the African Cape buffalo.

On territory marking, the African Cape buffalo territory marking activities are affected by infrastructural development in the park due to overlapping. The African Cape buffalo territories tend to overlap with other animal species in the park, therefore, causing conflicts amongst them. Occasionally, the African Cape buffalo territories spill over to the ranger bases, lodges and campsites which often cause human-wildlife conflicts. Human-wildlife conflict within the park often arises with solitary males which live in small groups of 2 to 23 members.

Finally, on defence, the African Cape buffalo moves in herds since they are social animals. The herds form their defence unit and build their confidence for security purposes. However, at times, infrastructural development such as houses may create barriers which may cause separation of the herds. Upon separation, individual buffalos become an easy target for carnivores such as lion, hyenas and leopards. Additionally, separated individual buffalo tend to be very aggressive as a security countermeasure causing human-wildlife conflict with the rangers living at the ranger base or any other person within the park.

CONCLUSION

The study demonstrated that infrastructure development in Lake Nakuru National Park has a significant negative effect on the African Cape buffalo's behaviour. The study further, inferred that infrastructural development has significant effects on African buffalo feeding, migration and breeding. Additionally, the study inferred that infrastructure development does not affect the African Cape buffalo breeding quantitatively, but rather qualitatively due to the physical stress caused by noise pollution as the infrastructure development is in use or under repair. Feeding was deduced as the most affected behaviour of the African Cape buffalo since infrastructure development eats upon the land which could be feeding grounds of the African Cape buffalo. Furthermore, the land available in the park is limited, yet there are 3500 African Cape buffaloes and other numerous browsers.

RECOMMENDATIONS

The sewage needs to be relocated to another area which will ensure that the browse available to the African Cape buffalo is clean and safe for consumption. Additionally, this will eliminate the disposal of semi treated sewage to Lake Nakuru. The park should be opened up towards Soysambu conservancy. This will enable the African Cape buffalo to migrate to the neighbouring ecosystem in search of food and water during dry seasons. The park management should limit the number of fenced and non-fenced infrastructure in the park. Limiting the number of infrastructural development within the park will avail more space for the African Cape buffalo.

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