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Valuation of Human- Hippopotamus Conflict: A Case Study of Kiri Dam, Shelleng Local Government Area, Adamawa State

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Abstract: This study examines human-hippopotamus conflict in Kiri Dam Shelleng Local Government Area, Adamawa State, Nigeria, focusing on its socio-economic impacts and community perceptions. Data were collected from 300 respondents in four (4) communities, including farmers, fishermen, herders, local leaders, and conservation officers, using structured questionnaires and field observations along the Dam. The findings indicate that 90.3 % of respondents observe hippopotamuses, primarily in water (47.2 %), farms (25.0 %), and fishing sites (18.4 %). Economic losses were reported by 70.3 % of respondents, with crop destruction (55.4 %) being the most significant impact, followed by fishing gear damage (22.7 %) and livestock loss (15.6 %). Direct conflicts affected 48.7 % of households, resulting in property damage (54.8 %), fear/displacement (28.8 %), and injuries (12.3 %). Key drivers of hippopotamus presence include food search (54.7%), habitat destruction (66.3%), and climate change (33.9 %), exacerbated by human activities such as farming near the dam (78.2 %) and fishing (71.7 %). Community perceptions are predominantly negative, with 53.7 % viewing hippopotamuses as dangerous pests and 21.9 % supporting community based conservation. Suggested mitigation measures include fencing (47.7 %) and awareness campaigns (45.5 %). The study recommends implementing non-lethal deterrents, community-based conservation with compensation schemes, and habitat restoration to promote sustainable coexistence and biodiversity conservation.

key words: Hippopotamus, Conflict, Habitat, Kiri dam

Introduction: The hippopotamus (hippopotamus amphibious) belongs to the family hippopotamidae, which includes to extant species the common hippopotamus and the pygmy hippopotamus (*Choeropsis beriesis*). The species is primarily found in sub-Saharan Africa, where it thrives in freshwater ecosystems such as rivers, lakes, and swamps (Eltringham, 2019). Hippos are characterized by their large, barrel-shaped bodies, short legs, and nearly hairless thick skin. Despite their resemblance to pigs, they are more closely related to cetaceans (whales and dolphins), sharing a common ancestor that lived over 55 million years ago (Gatesy *et al*., 2019). Adult male hippos, known as bulls, can weigh up to 1,500 kg, while females, called cows, are slightly smaller. These animals are predominantly nocturnal, spending their days submerged in water to regulate body temperature and emerging at night to graze on grasses (Olivier *et al*., 2020). Historical accounts suggest that hippos were once widespread across much of Africa, inhabiting freshwater ecosystems from West Africa to the Nile River Basin and extending to southern Africa. However, increasing human settlement and agricultural expansion have contributed to a rise in conflicts, particularly in rural areas where livelihoods depend on water resources shared with these large herbivores (Kanga *et al*., 2019). Traditional communities have historically viewed hippos as both a resource and a threat, utilizing their meat and ivory-like canine teeth for trade while simultaneously fearing their aggression and territorial behaviour (Parker *et al*., 2017). The colonization and subsequent industrialization of African countries in the 19th and 20th centuries led to increased deforestation, waterway modification, and habitat encroachment, exacerbating conflicts between humans and hippos (Lewison and Pluhácek, 2017). In regions such as East and Central Africa, hippos were frequently targeted by hunters due to their valuable hides and teeth, leading to a significant decline in their populations. This hunting pressure, combined with increasing land-use changes, forced hippos into smaller, fragmented habitats, heightening their interactions with human populations (Chomba *et al*., 2021). In modern times, the demand for agricultural land and

freshwater sources has further intensified, especially in countries such as Nigeria, Kenya, and Tanzania, where rapid population growth and economic expansion have, put pressure on natural ecosystems (Kibara *et al.*, 2020). The frequency of human hippopotamus encounters varies depending on the region for a contextual analysis of conflict patterns to develop effective migitation strategies (Mitanda *et a.*, 2019).

Globally, hippopotamus populations have been declining due to habitat destruction, poaching, and climate change. Estimates indicate that the total population of common hippos is between 115,000 and 130,000 individuals, with the highest concentrations found in protected areas of East and Southern Africa (Pienaar *et al*., 2020). Countries such as Zambia, Tanzania, and Botswana host significant populations, while in West Africa, numbers have dwindled due to habitat fragmentation and hunting pressure (Petrozzi *et al*, 2018). In many parts of Africa, hippos are subject to both legal and illegal hunting, with their meat and ivory-like teeth being highly valued in local and international markets (Barnett and Patterson, 2019). The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) lists hippos under Appendix Il, meaning that their trade is regulated to prevent overexploitation (Harrison *et al*., 2021).The primary challenges associated with hippopotamus conflicts stem from the increasing overlap of human activities with hippo habitats. As human populations grow, the demand for land and water resources intensifies, leading to greater competition between communities and wildlife (Dickman *et al*., 2019). Farmers living near rivers and lakes often experience significant crop losses due to nocturnal grazing by hippos, which can devastate subsistence agriculture and lead to economic hardship (Mkanda *et al*., 2018). Additionally, attacks on fishermen and local residents have resulted in injuries and fatalities, creating fear and resentment toward conservation efforts (Mwalyosi *et al*., 2021). The effects of these conflicts extend beyond human safety and economic loss, as retaliatory killings and habitat destruction further threaten hippopotamus populations (Junker *et al*., 2020).

Material and Methods: Area of the Study: The Kiri Dam is in Shelleng local government area of Adamawa State in the north eastern part of Nigeria, damming the Gongola River. Specifically, the dam is located between Latitude 09º 50 N and 10º 10′ N and Longitude 11º 90′ E and 12º 04′ E on the floodplain of the lower Gongola River basin (Figure 1). The dam is situated about 29 km upstream of its confluence with River Benue at Numan. It is a 1250 m long, 20 m high zoned embankment with an internal clay blanket. The reservoir has a capacity of 615 million m³ and a surface area of 134 km^2 (Enplan Group, 2004). The area has a sedimentary rock of shale and thin bands of limestone and lignite. It contains a wide range of alluvial deposits, along wide channels of River Benue and Gongola which overlies the cretaceous deposit. It is generally a lowland area, between 500 – 700 meters above sea level. The landforms of the area are characterized by extensive floodplains and alluvial swamps. Most of the locations are liable to flooding, water logging or swamps along river catchments. The subsoil and shale formation allow an underground flow of water, which raises the water table during the rainy season and drops very low during the dry season (Orosun *et al.*, 2017).

The rainfall regime in the area is a tropical continental type of single peak toll usually in August or September. The wet season ranges from April to October, with annual rainfall values of 510 – 1040 mm and the dry season lasts for about 7 months. Kiri area has a warm temperature with a mean annual minimum value of 18^0 C in December and a mean annual maximum of 38^0 C in March (Tukur and Mubi, 2019). The Dam was built following the mandate given to the Upper Benue River Basin Development Authority (UBRBDA) by the federal government of Nigeria to provide irrigation for the Savannah Sugar Company (SSC), a large-scale sugar cane plantation and processing company set up as a joint venture between the Nigerian Federal Government and the Commonwealth Development Corporation (CDC), London. The CDC was managing agent for the project, and the construction contract was awarded to NECCO, a company largely owned by the government (Samuel, 1998). The dam was mainly completed in 1982. The people living in communities around the dam use it daily. They use it for fishing, bathing, washing and collecting water for general use (Institution of Civil Engineers, ICE, 2016).

Research Design and Sample Size: The study focused on conflict-prone settlements along the Dam, where reports of crop destruction, attacks on fishermen, and competition for water resources are prevalent. The target population for this study includes farmers, fishermen, herders, local community leaders, and conservation officers at Kiri, Shelleng, Lubabiri and Tallum communities in the study area. A sample size of 300 respondents were selected. In determining the sample size of this research, Yamane's (1976) Statistical Formula was applied. The choice of this sampling technique was due to the nature of work and locations of respondents. The formula is presented as follows;

$$n=\frac{N}{1+N(e)^2}$$

Where:

n = total number of questionnaire administered

N = population of the study

e = % level of significance or margin of tolerable error

The researcher chose 5% as level of significance or margin of tolerable error.

Data Collection Methods: Structured questionnaires was administered to respondents to gather information on the frequency of hippopotamus conflicts and socio-economic impacts. The questionnaire included both closed and open-ended questions to capture quantitative and qualitative data. Likert-scale responses was used to assess community perceptions of hippopotamus threats and mitigation measures. Field observations was conducted along the dam to document hippopotamus signs of human-wildlife conflict. Journals, Proceedings, Texts, Brochure, and Manuals were used to elicit information for secondary data.

Statistical Analysis: Descriptive statistics was employed in the analysis of data. The descriptive statistics used are: Tables, means, frequency distribution and percentages.

Results: Socio-Economic Characteristics: Table 1 shows the Socio-Economic Characteristics of respondents. The majority of respondents are within the age bracket of 18 and 47 years (72.0 %). This is the energetic group of a society, indicating a significant portion of working-age population. Gender: The sample is slightly male-dominated (57.3 % male versus 42.7 % female), reflecting a balanced gender distribution. On the marital status more than half of the respondents (61.3 %) were married. The house hold size of 1-5 constitute the highest with 53.6 % of the respondents and the least is 21-25 (2.0 %). More than half of the respondents (57.0%) are farmers, followed by fishermen (26.3 %), traders (6.7%) and civil servants were 6.3 %. A significant portion (37.3 %) has primary education, while 34.0% have no formal education, 21.7 % secondary, and 7.0 % tertiary education.

Respondent opinion on Hippopotamus Presence Table 2 shows the Respondent Opinion on Hippopotamus Presence - A high percentage (90.3 %) of respondents have seen hippopotamuses in their area, indicating frequent human-wildlife interactions. Among those who have seen them, sightings are most common monthly (38.7 %) or weekly (23.0 %), with only 3.7 % reporting rare sightings. Hippopotamuses are most commonly seen in water (47.2 %), followed by farms (25.0 %), fishing sites (18.4 %) and (9.4 %) report sightings near settlements.

Economic Losses Due to Hippopotamus: Table 3 shows Respondent Opinion on Economic Losses Due to Hippopotamus. 70.3 % of respondents have experienced economic losses due to hippopotamuses, highlighting a significant economic impact. Among those affected, crop destruction is the most common loss (55.4 %), followed by fishing gear damage (22.7 %), livestock loss (15.6 %), and injuries or medical costs (6.2 %). Losses occur multiple times a year (41.7 %) or every season (31.2 %), indicating recurring economic challenges.

Human–Hippopotamus Conflict: Table 4 shows the Respondents Opinion on Human–Hippopotamus Conflict. 48.7% of households have experienced direct conflict with hippopotamuses, with property damage (54.8 %) and fear/displacement (28.8 %) being the most common outcomes. Injury to persons (12.3 %) and death of persons or animals (2.7 %) are less frequent but still significant. After conflicts, 32.0 % reported to authorities, 36.8 % took self-defensive actions, 15.2 % relocated temporarily, and 16.0 % did nothing.

Drivers of Hippopotamus Presence: Table 5 shows the Respondents Opinion on Drivers of Hippopotamus Presence. Respondents attribute hippopotamus presence near human areas to searching for food (54.7 %), habitat destruction (66.3 %), climate change (33.9 %), and increased hippopotamus population (21.1 %). 81.0 % believe human activities influence hippopotamus movement, with farming as the most cited with (78.2 %) then fishing near rivers (71.7 %), followed by sand mining (21.5 %) and bush burning (13.7 %).

Community Perception: Table 6 shows the Respondent Opinion on Community Perception. Most respondents (53.7 %) view hippopotamuses as dangerous pests, while 34.0 % see them as wildlife to be conserved, 26.7 % as sacred/traditional animals, and 23.3 % as a food source. This indicates a predominantly negative perception. 53.0 % of the respondents oppose protecting hippopotamuses in there area, 30.3 % support protection, and 16.7 % are unsure, reflecting divided opinions. Only 21.9 % support community-based conservation, 54.0 % oppose it, and 24.0 % would support it with compensation. : Fencing around farms/rivers (47.7 %) and awareness campaigns (45.0 %) are the most favoured measures to reduce conflicts, followed by, compensation (23.0 %), relocation (20.3 %) and deterrents (17.0 %).

Discussion: The demographic profile indicates that the majority of respondents (85.0 %) are within the age bracket of 18 and 47 years. This is the most active segment of the population involved in farming and fishing activities. This age group is more likely to encounter hippopotamuses during agricultural activities, thereby increasing exposure to conflict. Similar age-related exposure patterns have been reported in studies on human–wildlife conflict in rural African communities (Ogada *et al*., 2016; Barua *et al*., 2018). Majority of the respondents (61.3 %) were married this is an indicative of fast population growth in the communities. This therefore means more pressure on natural resources. This agrees with Ijomah and Akosim (2000) observation on the relationship between population growth and resource conservation. The relatively balanced gender distribution (57.3 % male, 42.7 % female) suggests that both men and women are directly affected, though men may be more exposed due to outdoor activities. Farming (57.0 %) and fishing (26.3%) as the dominant occupations reflect the community's dependence on natural resources, which intensifies the risk of human–hippopotamus interaction. Studies in Nigeria and East Africa similarly show that agrarian and fishing populations bear the highest cost of wildlife conflict (Distefano, 2019; Eniang *et al*., 2020).

Low educational attainment constituting of primary and informal education with 37.3 % and 34.0 % respectively may limit awareness of conservation strategies and formal conflict-mitigation programs. Previous research highlights that low literacy levels in rural areas often lead to negative perceptions of wildlife and limited participation in conservation initiatives (Gandiwa *et al*., 2016). A majority

of respondents (87.0 %) reported sighting hippopotamuses in their area, with monthly (38.7 %) and weekly (23.0 %) encounters being most common. Previous ecological studies shows that hippos frequently move between rivers and farmlands in search of water and forage, especially during dry seasons (Lewison and Carter, 2017). The common sighting locations—water (47.2 %), farms (25.0 %), and fishing sites (18.4 %)—demonstrate the spatial overlap of hippo habitats with human economic activities. Such overlaps have been identified as the major drivers of human–wildlife conflict in riparian ecosystems (Nkya *et al*., 2020).70.3 % of respondents reported economic losses, with crop destruction (55.4 %) as the most severe impact. This aligns with findings in Ghana and Tanzania where hippopotamuses are considered one of the most destructive crop-raiding animals (Hill, 2018; Chomba *et al*., 2021). Damage to fishing gear (22.7 %) and livestock (15.6 %) also highlight the multi-dimensional nature of losses beyond crops. The fact that losses occur multiple times a year (41.7 %) or every season (31.2 %) suggests that conflict is chronic rather than incidental. Chronic wildlife damage has been linked to increased hostility towards wildlife and reduced tolerance for conservation efforts (Thouless, 2016; Barua *et al*., 2018). 48.7 % of households reported direct conflict, with property damage (54.8 %) and fear/displacement (28.8 %) being the most common outcomes. These findings resonate with Chomba *et al*. (2021), who reported that hippos frequently damage crops and properties near water bodies. Injuries (12.3 %) and deaths (2.7 %) demonstrate that hippos are not only an economic threat but also a significant safety hazard. The IUCN (2021) lists hippos among the most dangerous large mammals to humans, responsible for numerous fatal attacks annually. Community responses included reporting to authorities (32.0 %) and self-defensive action (36.8 %). However, limited institutional intervention often forces communities into direct confrontation with wildlife, escalating risks (Eniang *et al*., 2020).

Respondents identified searching for food (54.7 %) and habitat destruction (66.3 %) as the main drivers of hippo encroachment. Human activities such as farming near rivers (78.2%) and fishing (71.7%) were also acknowledged as influencing hippo movement. This reflects broader findings in sub-Saharan Africa that agricultural expansion into wetlands and riparian zones intensifies human–wildlife conflicts (Distefano, 2019; Graham *et al*., 2020). Climate change (33.9 %) was also mentioned, highlighting the role of climate variability in altering hippo behavior. Research shows that droughts reduce water and grazing resources, pushing hippos closer to human settlements (Lewison, 2018). The majority (53.7 %) perceived hippos as dangerous pests, while only 34.0 % saw them as wildlife worth conserving. Negative perceptions are common in areas where wildlife causes recurrent losses (Hill, 2017; Gandiwa *et al*., 2016). 24.0 % expressed conditional willingness to support community-based conservation if compensation were provided, reflecting findings that economic incentives improve tolerance towards wildlife (Dickman *et al*., 2021). Suggested mitigation measures included fencing (47.7 %) and awareness campaigns (45.0 %). These align with recommended strategies in human–wildlife conflict management literature, emphasizing both preventive (barriers, deterrents) and non-lethal (education, compensation) approaches (Nyhus, 2016).

Conclusion: This study investigated the variation of hippopotamus conflict in Kiri Dam . The findings reveal that human–hippopotamus interactions are frequent and pose significant economic, safety, and social challenges to local communities. The majority of respondents are within the productive age group, primarily farmers and fishermen, whose livelihoods directly overlap with hippopotamus habitats. The results show that hippopotamuses are commonly sighted near rivers, farms, and fishing sites, with crop destruction and fishing gear damage being the most reported losses. These conflicts occur multiple times a year, demonstrating their chronic nature. In addition to economic impacts, hippopotamuses also cause property damage, injuries, and occasional fatalities, heightening fear and displacement among residents. Key drivers of hippopotamus presence include food search, habitat destruction, climate change, and human activities such as farming near rivers and fishing. Community perception is largely negative, with most respondents viewing hippopotamuses as dangerous pests rather than wildlife worth conserving. However, a portion of the population expressed w**ill**ingness to support conservation if provided with compensation. Overall, the study concludes that the conflict between humans and hippopotamuses in the study area is a pressing conservation and development issue, threatening both livelihoods and biodiversity. Without effective interventions, hostility toward hippopotamuses may intensify, further undermining conservation efforts.

Recommendations: Introduce fencing and buffer zones along farmlands and dam to reduce crop raiding and property damage. Promote the use of non-lethal deterrents such as noise devices, lights, or community watch systems to keep hippopotamuses away from settlements. conduct awareness campaigns on human–hippopotamus conflict management, emphasizing coexistence strategies and safe practices near rivers. Integrate conservation education into local schools and community programs to improve understanding of hippopotamus ecology and their role in ecosystems. Establish compensation mechanisms or insurance schemes for households that suffer losses, which could reduce hostility and build tolerance. Introduce alternative income-generating activities (e.g., aquaculture, beekeeping, small-scale businesses) to reduce dependence on farming and fishing in hippo-prone areas. Improve the response capacity of local authorities and wildlife agencies to address conflicts more promptly and effectively. Develop local bylaws restricting farming and sand mining close to Dam to minimize overlap with hippopotamus habitats. encourage community involvement in conservation projects through benefit-sharing arrangements (e.g., ecotourism, wildlife-based enterprises). Support conditional conservation programs where communities receive incentives or development projects in exchange for protecting wildlife. implement habitat restoration programs to reduce habitat loss and food scarcity for hippopotamuses. Incorporate climate adaptation strategies into local development planning to mitigate the effects of drought and water scarcity that exacerbate wildlife movements into human areas.

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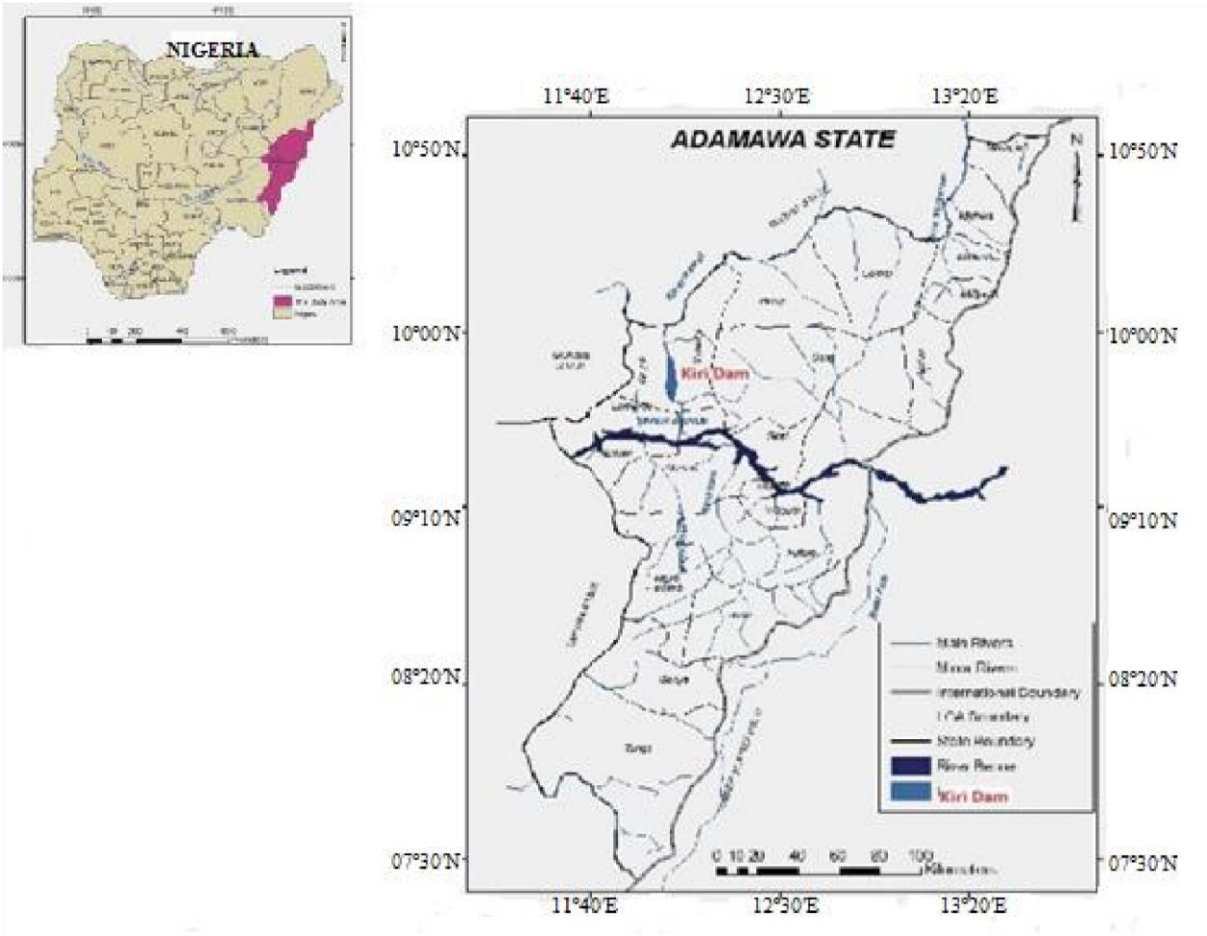

Table 1: Socio-Economic Characteristics Respondent

Age	Frequency	Percentage (%)
18-27	71	23.7
28–37	87	29.0
38–47	58	19.3
48–57	45	15.0
58-67	22	7.3
68 above	17	5.7

Gender		
Male	172	57.3
Female	128	42.7
Marital status		
Married	184	61.3
Single	92	30.7
Divorced	11	3.7
Widow	8	2.7
Widower	5	1.7
House hold size		
1-5	161	53.6
6-10	99	33.0
11-15	21	7.0
16-20	13	4.3
21-25	6	2.0
Occupation		
Farmer	171	57.0
Fisherman	79	26.3
Trader	20	6.7
Civil Servant	19	6.3
Others	11	3.7
Level of Education		
Informal education	72	34.0
Primary	142	37.3
Secondary	65	21.7
Tertiary	21	7.0

Table 2: Respondent opinion on Hippopotamus Presence

Have you seen a hippopotamus in your area	**Frequency**	**Percentage (%)**
Yes	271	90.3
No	29	13.0
how often do you see them		
Daily	20	6.7

Have you seen a hippopotamus in your area		Frequency	Percentage (%)
Weekly		69	23.0
Monthly		116	38.7
Seasonally		55	18.3
Rarely		11	3.7
No	29		9.7
Where do you usually see them			
Water		151	47.2
Farms		80	25.0
Fishing sites		59	18.4
Nearby settlements		30	9.4

Table 3: Respondent opinion on Economic Losses Due to Hippopotamus

Experienced any economic loss due to hippopotamus	Frequency	Percentage (%)
Yes	211	70.3
No	89	29.7
kind of loss did you suffer		
Crop destruction	117	55.4
Fishing gear damage	48	22.7
Livestock loss	33	15.6
Injuries or medical cost	13	6.2
How often do these losses occur		
Once a year	29	13.3
Multiple times a year	91	41.7
Every season	68	31.2
Rarely	30	13.6

Table 4: Respondent opinion on Human–Hippopotamus Conflict

Household had a direct conflict with a hippopotamus	**Frequency**	**Percentage (%)**
Yes	146	48.7
No	154	51.3
Yes Household had a direct conflict with a hippopotamus		
Property damage	80	54.8
Injury to person	18	12.3
Death of person or animal	4	2.7
Fear/displacement	42	28.8
Action take after the conflict		
Reported to authorities	40	32.0
Took self-defensive action	46	36.8
Relocated temporarily	19	15.2
Did nothing	20	16.0

Table 5: Respondent opinion on Drivers of Hippopotamus Presence

Why are hippopotamuses coming close to human areas	**Frequency**	**Percentage (%)**
Climate change	101	33.9
Habitat destruction	199	66.3
Searching for food	164	54.7
Increased population of hippos	63.3	21.1
Human activities are influencing hippopotamus movement		

Why are hippopotamuses coming close to human areas	Frequency	Percentage (%)
Yes	243	81.0
No	49	16.4
Not sure	8	2.6
If Yes, what kind of activities?		
Farming near dam	235	78.2
Sand mining	65	21.5
Fishing	215	71.7
Bush burning	41	13.7

Table 6. Respondent opinion on Community Perception

How do you perceive hippopotamuses	Frequency	Percentage (%)
Dangerous pests	161	53.7
Sacred/Traditional animals	80	26.7
Wildlife to be conserved	102	34.0
Food source	70	23.3
Hippopotamuses be protected in your area		
Yes	91	30.3
No	159	53.0
Not sure	50	16.7
Support community-based conservation of hippopotamuses		
Yes	65	21.9
No	161	54.0
Maybe, with compensation	71	24.0
measures do you suggest for reducing human-hippopotamus Conflicts		
Fencing around farms/rivers	143	47.7
Awareness campaigns	135	45.0
Relocation of hippos	61	20.3
Compensation for losses	69	23.0
Use of deterrents (e.g., fire, noise)	51	17.0