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Common hippopotamus-human conflicts in Ouémé River area in central Benin Republic

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ABSTRACT: The common hippopotamus belongs to the threatened species that urgently need conservation programs. In this perspective, a study on the relationships between the species and human was conducted in areas surrounding the Ouémé River in Benin. This study aims to assess the types of damages caused by hippopotamus and conflict mitigation solutions- in order to facilitate pacific cohabitation between hippopotamus and human. A total of 180 people were interviewed in 6 villages using structured and semi-structured interviews. Our results indicated that the main damage caused by common hippopotamus was crops raiding (81.67 % respondents). Most respondents (53.89 %) declared that hippopotamus caused damage to their crops in farmland during the whole year, but period for raids varied significantly between villages ($\chi 2 = 57.926$, $p < 0.0001$). This study highlights the necessity to implement mitigation measures in order to promote pacific cohabitation between hippo and human.

KEYWORDS: Human-wildlife conflict, Mitigation measures, *Hippopotamus amphibius*, Crops damages.

1 INTRODUCTION

Human-wildlife conflicts, are recurrent issues in wildlife conservation throughout the world, and have negative impacts on both human and wildlife populations [1]. It became a threat to the survival of many species, in particular to large herbivores such as the African elephant *Loxodonta africana* the common hippopotamus *Hippopotamus amphibius* and the Buffalo *Syncerus caffer* [2], [3], [4] but also to carnivores such as the lion *Panthera leo,* the leopard *Panthera pardus*, the hyaena *Crocuta crocuta* and the crocodile *Crocodylus niloticus* [5]. The destruction of crops, attacks on fishermen by the destruction of canoe nets/attacks, livestock depredation and loss of life are frequently forms of conflict observed with wildlife [6], [7], [8]. The fast human population growth, land use change, species habitat loss and climatic factors are previously reported as major factors which contributed to the aggravation of human-wildlife conflicts in Africa [9], [10], [11].

Human-hippopotamus conflict is a key example of such an interaction in Africa. The hippopotamus is a large mammal belonging to the Hippopotamidae family (suborder of Artiodactyla, order of Ungulates). [12] estimated that the common hippopotamus population were reduced by 7 to 20% the last century. This decline was attributed to human activities consequences, mainly habitat loss as wetlands are converted or impacted by agricultural development. According to [13], [14] during the last few decades, hippopotamus decline results mostly in the human-hippopotamus conflicts. These conflicts result not only in serious threats to hippopotamus population but have negative impacts on local economy and population livelihood due to crops destruction [4]. In Benin, apart from the protected areas where hippopotamus is well secured, their presence in the Ouémé River outside protected areas remain a great challenge for wildlife managers despite the species status [15]. The issue is evident in Ouémé river - one of the last refuge of common hippopotamus in central Benin, where the human and wildlife interactions continue to increase because of the changing human demographics and the related land use practices [16]. In this situation, a better understanding of the causes of the human-hippopotamus conflicts are essential for the development and implementation of effective mitigation strategies [2]. Unfortunately, few authors have considered the human-hippopotamus conflicts in Benin and in study area especially. Therefore, this study was implemented as a case study of human-hippopotamus conflicts in Benin and intend to find effective solutions for a pacific cohabitation between human and

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hippopotamus which can be largely used. The study aims are: (i) to assess the causes and the manifestations of human-hippopotamus conflicts; (ii) to identify the mitigation strategies applied by local populations to cope with the hippopotamus attacks in order to promote pacific cohabitation between human and hippopotamus.

2 MATERIAL AND METHODS

2.1 STUDY AREAS

The study was conducted in the department of Collines in Benin located at the latitude 7°42' - 8°30' N and longitude 2°05' - 2°45' E. This area included two localities (Savè and Dassa-Zoumè) (Fig 1). The region belongs to the Sudano-Guinean climatic zone referring to the transition zone between the Guinean and Sudanian zones [17]. The rainfall regime is unimodal with a mean annual rainfall of 1000-1100mm (ASECNA, unpublished data). The mean annual temperature ranges from 26 to 28°C. The study area is mainly watered by the Ouémé River (450 km) which provides a safe haven particularly during the dry season for the common hippopotamus [18]. The main activities of local population in the area are agriculture "slash and burn cultivation" followed by livestock raising [16]. Uncontrolled logging for coal production is an increasing activity in the area [16]. Nowadays, despite law prohibition, lands as well as uncontrolled logging were done closed to the Ouémé river by local population. Unfortunately, this situation increases human-hippopotamus conflicts since shifting cultivation around rivers reduces hippopotamus grazing area and exacerbates the rivers filling by erosion. Three major socio-linguistic groups are listed and represented by "Idashaa", "Tchabè" and "Mahi" [19].

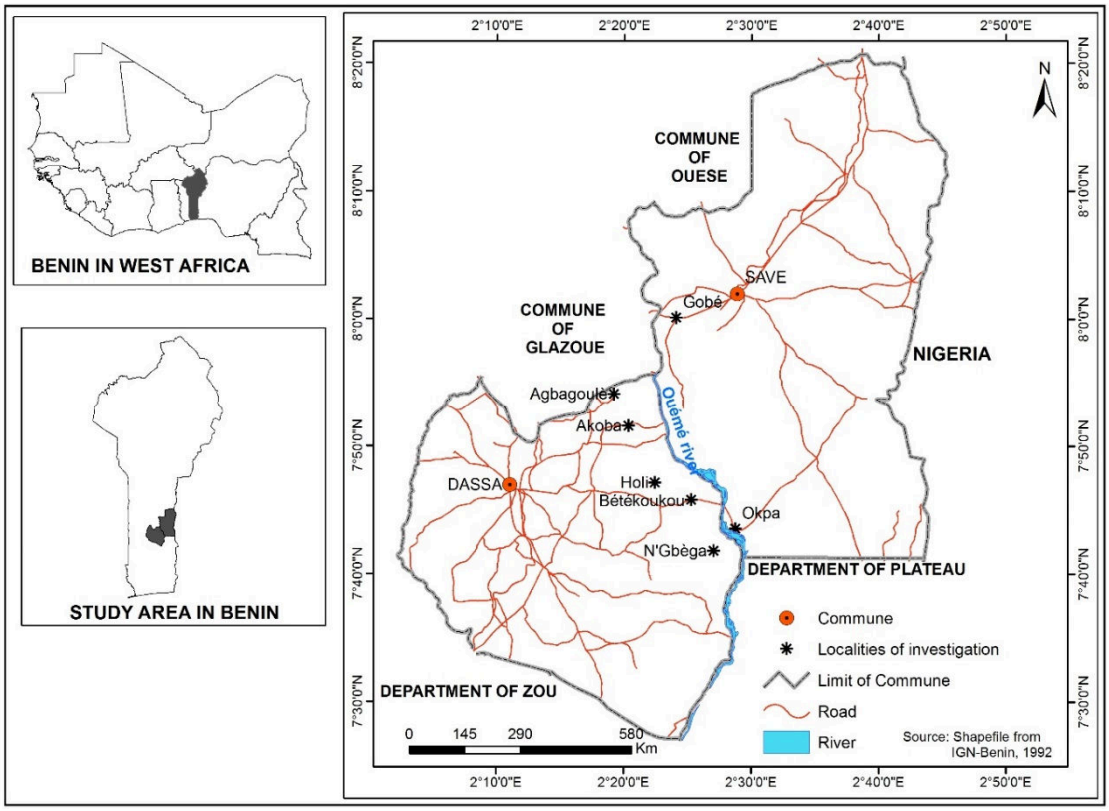

Fig. 1. Study area

2.2 METHODS

To collect data on human-hippopotamus conflicts, structured interviews using questionnaires were carried out with 180 victims of crop damages from hippopotamus chosen in 6 villages (Agbagoulè, Akobe, Bétékoukou, Holi, Okpa and Gobé) around the Ouémé River from June to November 2016. The main questions asked during the investigation were related to (i)- type of conflicts, (ii)- growth stage of the damaged crops, (iii)- distance from respondents' farmland to the river, (iv)- damages extent

based on the scale (1= low extent, 2 = intermediate extent and 3 = high extent) and (v)- types of mitigation/adaption measures used by population against hippopotamus damages.

2.3 DATA ANALYSIS

Chi-square test was used to assess whether the period of hippopotamus crop raiding occurrence depend on the investigated villages. Logistic regression was used to assess the factors which significantly influenced the probability of hippopotamus-human conflict occurrence in the area. The factors tested are: i)-farm distance from river, ii)-farm extent, iii)-crop growth stages and iv)-hippopotamus group size. A data matrix of the relative frequencies of the mitigation measures per village was submitted to principal component analysis to determine the relationship between the mitigation measures and the surveyed villages.

3 RESULTS

3.1 DAMAGES CAUSED BY HIPPOPOTAMUS

Four damages caused by hippopotamus were reported in the study area. Crop damages in the farmland, human death, injury and fluvial navigation disturbance were the reported damages by local population. About 81.67 % of all respondents quoted crop damage whereas 17.78 % and 8.89 % of respondents quoted respectively human injury and fluvial navigation disturbance. Fewer respondents (5.56 %) mentioned human mortality (Fig 2). There was no significant change for the types of damages between the investigated villages ($\chi^2 = 5.823$, $p = 0.983$).

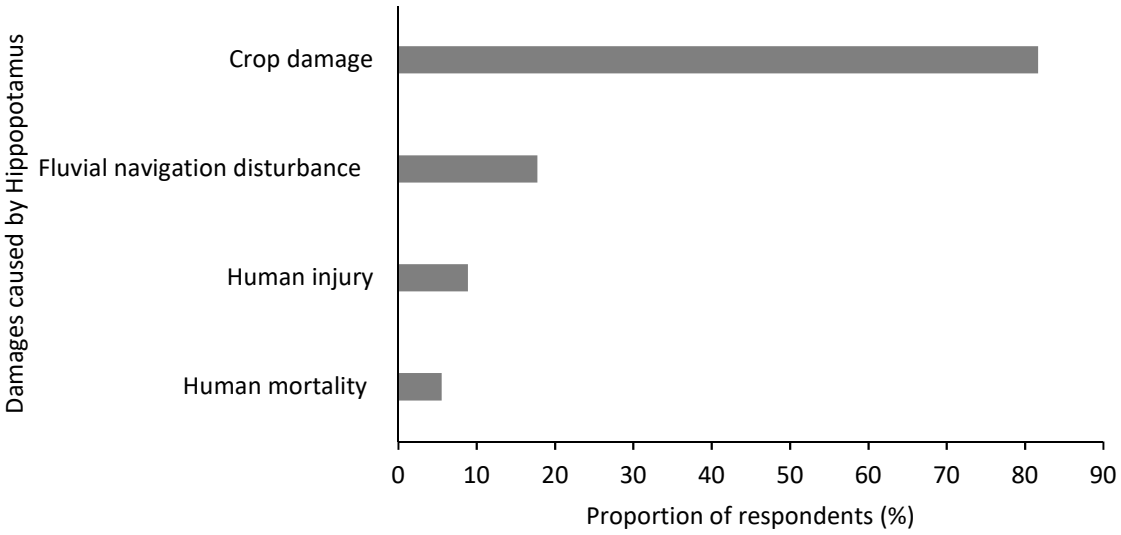

Fig. 2. Percentage of respondents reporting damages caused by hippopotamus

3.2 SPATIO-TEMPORAL DISTRIBUTION OF HIPPO CROPS RAIDING

Maize, peanut, rice, cotton, cassava, yams and various vegetables crops were the most frequently attacked crops by hippopotamus in the study area. Survey showed that Okpa and Bétékoukou villages had the highest incidence of crop damage by hippopotamus. During a day, the period of the crops raiding was at night corresponding to hippopotamus time for grazing. Most respondents (53.89 %) opined that hippopotamus attacked cropland during the whole year, but period for raid varied significantly between villages ($\chi^2 = 57.926$, $p < 0.0001$). In dry season, the vegetables crops installed at the borders of wetlands are mostly attacked. Damages to crops also were intensified in rain period (July to October) during the vegetative or at maturity stage.

3.3 KEY DETERMINANTS OF HIPPOPOTAMUS CROP RAIDING

Logistic regression analysis showed that farms extent (p = 0.226), crops growth stage (p = 0.856), hippopotamus groups size (p = 0.605) or illegal poaching (p = 0.461) had no significant influence on the probability of hippopotamus crops raiding occurrence in the area. However, distance from the farmlands to water source showed significant effect on crop raiding (p=0.003) (Table 1). In general, the hippopotamus attacked in the farm was located in a ray of few kilometers from the Ouémé river (4.36 ± 3.26 km). Mann-Whitney test revealed a significant difference between the distance from water source to the attacked farms and distance from water source to non-attacked farms (W = 2965.5, p <0.0001). Table 1. Factors determining hippopotamus crops raiding in farms.

Table 1. Factors determining hippopotamus crops raiding in farms

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	1.858	1.678	1.108	0.268
dist_farmland	-0.510	0.172	-2.967	0.003**
Farm_extent	0.942	0.779	1.210	0.226
Crop_growth_Stage	-0.118	0.652	-0.181	0.856
Hippo_group_size	0.053	0.103	0.517	0.605
Illegal_poaching	-0.569	0.7721	-0.737	0.461

3.4 MITIGATION MEASURES USED BY LOCAL POPULATION AGAINST HIPPOPOTAMUS CROP DAMAGES

Local farmers use traditional mitigation measures to prevent crop damages caused by hippopotamus in their farms. These include barbed wire fences, dry vegetation barrier; pole barrier, guarding farm, lighting fires, shouting and drums noise (Fig 3). Principal Component Analysis (PCA) revealed that farmers whose farms were not damaged, prioritized mitigation measures as: the guarding farm, the pole barriers and the barbed wire fences. Conversely, the farmers who use deterrents such as shouting, drumming and lighting fires had once suffered from hippopotamus damages (Fig 4).

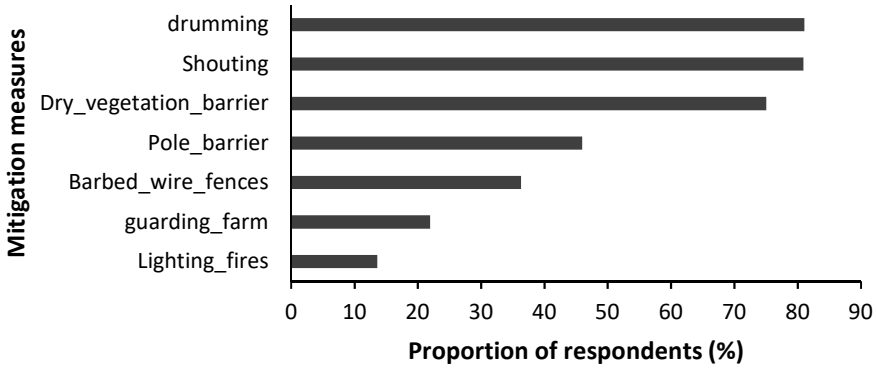

Fig. 3. Percentage of respondents reporting mitigate measures used by local population to to prevent crop damage caused by hippopotamus

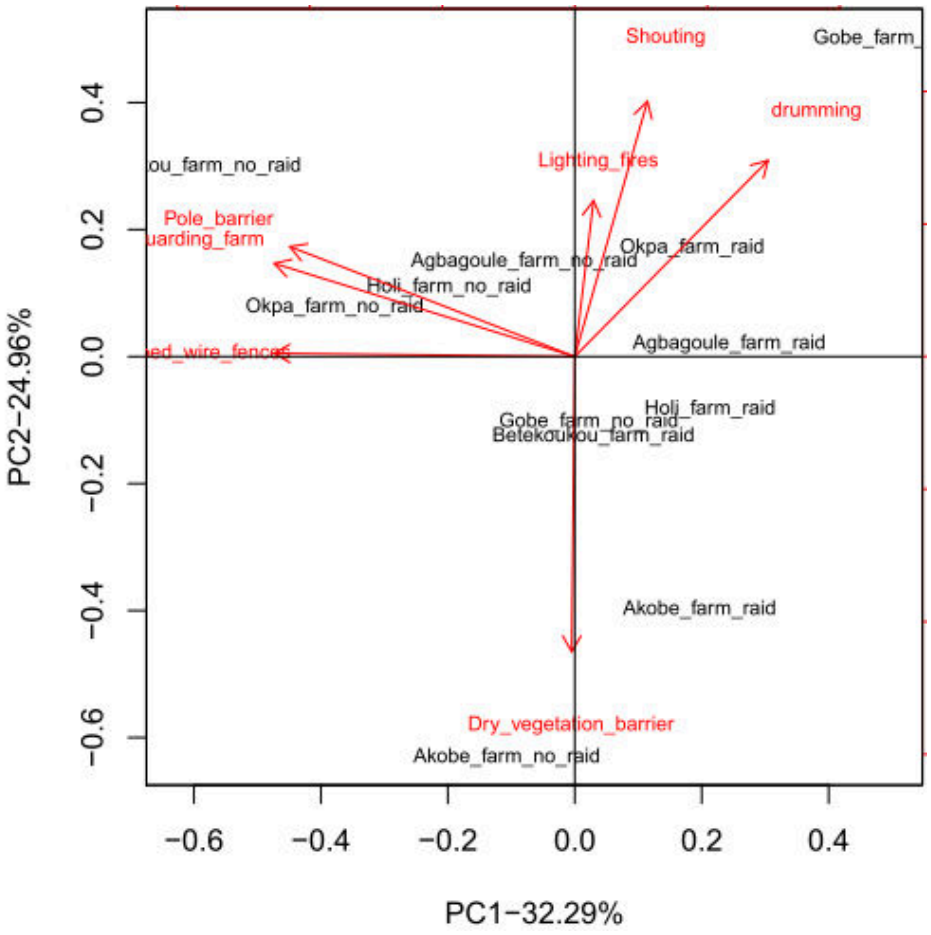

Fig. 4. Projection of mitigation measues/villages in the principal component analysis (PCA)

4 DISCUSSION

4.1 DAMAGES CAUSED BY HIPPOPOTAMUS

This study revealed four major damages and losses caused by hippopotamus in study area. The crops attacked in the field emerged as the source of human-hippo conflict. Previous studies performed on Adjamè community reserve in south-eastern Benin showed that human hippopotamus conflicts are linked in the majority to crops attacked by hippopotamus [4]. In Kenya, [20] reported that about 78 % of the conflict incidences (agricultural and physical threats) are associated with human-induced land use changes. Overall, wetlands conversion to agricultural land restricted access to water and the loss of hippopotamus grazing area and migratory corridors leading to conflicts between human and wildlife [13]. In addition to crops destruction, attacks on fishermen and loss of life are considered as an important factor contributing to the persistence of human-hippopotamus conflicts [4], [14], [18].

4.2 PERIOD AND FACTORS DETERMINING CROP DAMAGE

In this study, results showed that the occurrence of crop damages by hippopotamus is important in rainy periods (April in November) on maize, cassava and peanut. In dry season, the vegetables cultivated on the shore of Ouémé river are more attacked. Our findings are in accordance with the results of [20] which reported that the looting of the fields takes place mainly at the beginning of the dry season, either during the period where the majority of crops reached maturity in Kenya. The rapid progression trend of the agricultural frontline around the rivers and lakes is a great concern [21]. This situation highlights the increasing of human-hippopotamus conflicts. The proximity of farmland from rivers or lakes indubitably contributes to increase human-hippopotamus conflicts. Some authors also suggested that drought and competition with livestock can constrain hippopotamus to graze far from the river increasing the area of conflicts with humans [20].

4.3 MITIGATION MEASURES TO PREVENT

To cope with hippopotamus damages in the farmland, local population in the study region used different methods depending on their history with hippopotamus attacked in their farm. Repelling measures adopted by the farmers range from preventive measures (barriers settlement, shouting, drumming and lighting) to hippo killing. Ours results are in accordance with those of [4], [7] who reported the utilization of pole barriers, barbed wire fences, shouting, drumming and fires used to repel wildlife from the farm. However, the effectiveness of the methods used remain questionable. Methods such as shouting, drumming and lighting require the presence of human during the night when hippopotamus attacks the crops in the fields. Human presence in the field during the night represents a real limit to the success of these methods. Pole barriers made of traditional material and the barbed wire fences installation could be a good alternative to avoid permanent presence of human in the field during the night. Unfortunately, the settlement of such barriers (barbed wire fences) are costly for local farmers and required permanent maintenance due to its destruction by hippopotamus. In the case of elephant repelling from crops destruction, [22] mentioned that physical barriers installation can be effective but very expensive, since its require important investment and constant maintenance. For [23], strategies based on electric fences are effective to repel wildlife from the farmland. However, the high costs of these facilities make their application on large scale little realistic in the developing countries and cannot be installed by local farmers who practices subsistence agriculture [24]. In addition, the use of electric fences is little recognized because of the risk of materials theft which makes this approach little effective [22], [24]. Repelling methods based on fences are perceived as a source of equipment of traps for the poachers and involuntarily interfere with the conservation of other species [6].

This study demonstrated clearly that the arrow of methods used by farmers in the study area remain less effective. For a pacific cohabitation between hippopotamus and human, we suggest optimal delimitation of hippopotamus habitat in the study area which will be erected as community reserve where human activities which can compete with hippopotamus habitat will be locally prohibited. This reserve will be designed in closed collaboration with the local population, authorities and wildlife managers. Moreover, suitable alternatives activities generating income will be implemented towards local population to meet their daily needs.

5 CONCLUSION

The crop destruction in the farmland is the major damage caused by wild hippopotamus in study area. Maize, peanut, rice, cotton, cassava, yams and various vegetables crops were the most frequently attacked crops by the hippopotamus. Local farmers use traditional mitigation measures as barbed wire fences, dry vegetation barrier; pole barrier, guarding farm, fires, shouting and drums noise to prevent crop damage caused by hippopotamus in their farms. Farmland proximity from Ouémé river was the most important factor increasing human-hippopotamus conflicts in the study area. There is a need to find reliable solutions to cope with hippopotamus raids in the field and to promote pacific cohabitation between human and hippopotamus. Finally, the study suggests reserve designing in the present habitat occupied by the hippopotamus in the area.

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