Elephant Conservation Planning and Monitoring in the Mozambique Central Ecosystem Using Geographic Information System and Remot Sensing

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Introduction

Protected areas in developing countries are faced with a number of management challenges and this has led to a loss of habitat, the largest threat facing wildlife in Africa in particular for large mammals. The reduction of large habitats to smaller and isolated remnants cut-off migration corridors and affects their abundance and distribution. As a result when wild fauna move beyond their sanctuaries in search of food they inevitably run into trouble, often from farmers sleeping on their farms trying to protect their crops.

In order to secure habitats and their wild animals we used Geographic Information System-GIS and Landsat ETM+ Satellite to understand and monitor where the animals are, what they are doing, how do they do, why such behavior and which sites are of priority for future conservation.

Objectives

(a) Determine the elephant distribution
(b) Map the habitat diversity distribution
(c) Examine the relationship between habitat types and Elephant distribution
(d) Determine the key variables that explain the seasonal habitat selection or avoidance by elephant; and
(e) Design the candidate habitats for Elephant conservation.

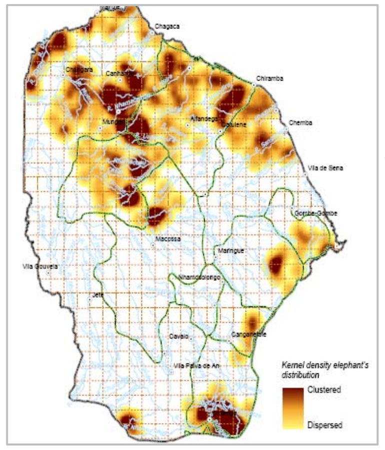
Study area

Mozambique central ecosystem

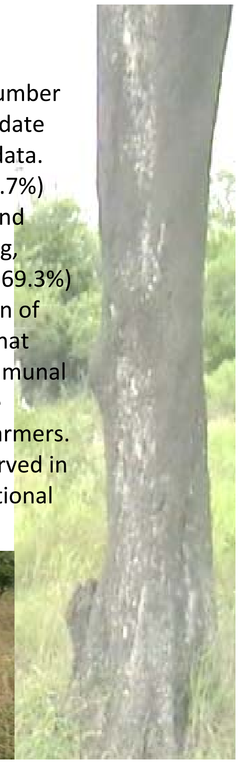
Methods and materials

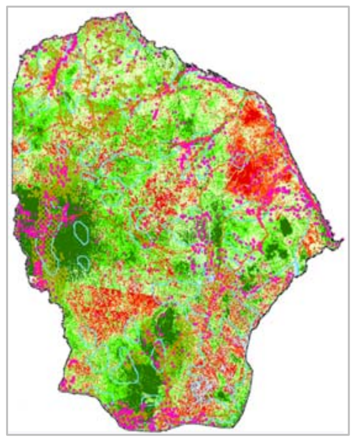
We used interviews recorded in digital camera to know elephant history in the study area. Transects and direct observation aided by Global Positioning System-GPS were used to survey the signs that elephant left when using the landscape units. Data on elephant signs were analysed by means of kernel density and kernel spatial movement to obtain elephant density, home ranges and corridors.
Normalized Difference Vegetation Index-NDVI and quadrates supported by GPS were used to sample vegetation types. Results of field survey were then analysed using Biodiversity indexes and overlaid to NDVI and topographic profile to delineate habitat types and to understand species diversity variability along the altitudinal gradient.
Spatial correlation was used to calculate the degree of association between elephant distribution and habitat types. The extent to which one habitat was utilized by elephant in relation to another was tested using Repeated ANOVA. And to know why elephant selected or avoided some habitats by time and space, Adjusted Coefficient of Determination was estimated.
Kriging interpolation of ranking scores; numerical clusters and NDVI were finally applied to prioritize sites for elephant conservation.

Results and analysis

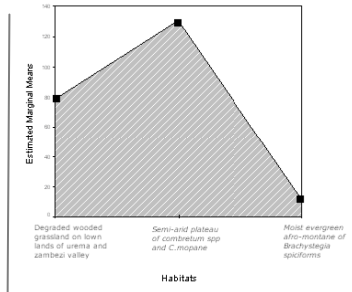


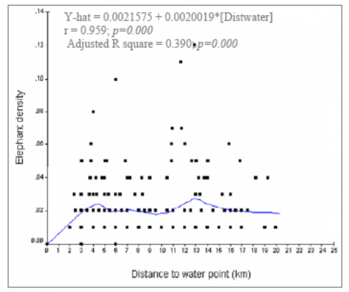
Elephant distribution: a total number of 404 sites were located to validate different sources of secondary data. Between these samples 124 (30.7%) represented footprints, tracks and trails, foraging, watering, barking, probing and carcasses and 280 (69.3%) were dung-piles. The distribution of signs validated the hypothesis that elephant is mostly found in communal land (48.54%), sharing the same resources with smaller holder farmers. Less core home range was observed in hunting blocks (35.00%) and national parks (16.45%).

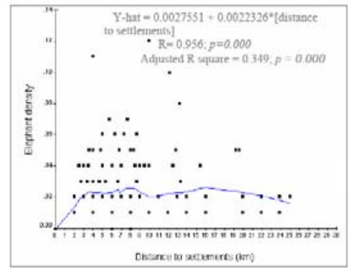




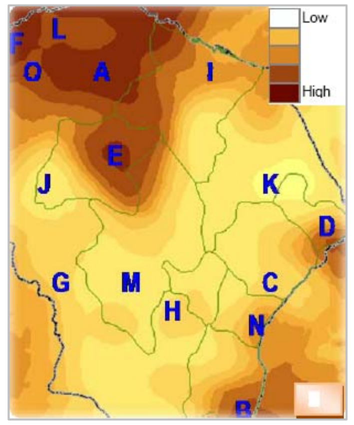
Habitats diversity: three habitats were documented ranging from moist evergreen afro-montane of *Brachystegia spiciformis (dark green on the map)*; semi-arid plateau of *combretum spp* and *Colophospermum mopane (light green)* and degraded lowlands of Urema and Zambezi floodplains *(weak green and red patches on the map)*. NDVI performance differed significantly (*p = 0.000*) between the habitats, expressing the larger effect size variability between them (Partial Eta= 0.952; *p=0.000*). Further, NDVI increases with altitude (r=0.945, *p= 0.001*) and decreases with plant richness (r= -0.416; *p= 0.727*).







Relationship between Elephant distribution and habitats diversity:
Results suggested that elephant use all habitats when available, (53.54%) semi-arid plateau, (34.92%) degraded wooded grassland and (11.54%) moist evergreen afro-montane but when the habitat influencing factor becomes more severe, their preference is narrow. For this issue, Repeated ANOVA has shown a near to strong effect (partial Eta = 0.5) of the differentiation between habitats use by elephant although this segregation was not at all significant (*p = 0.07*). Thus, elephant habitat use was significantly (*p = 0.003*) different between the semi-arid plateau and the moist evergreen afro-montane. The first habitat was 118.51 times more utilized than the second. Elephant habitat use was detrimental to water availability (40.2%; *p=0.000*), human activities (36.80%; *p=0.000*) and vegetation diversity (35.00%; *p=0.000*). Aridity index mostly (8.3%; *p=0.000*) determined the factors influencing elephant habitat use at different habitat types, confirming the hypothesis that elephant survivor in the ecosystem was any strategy of adaptation to the impacts of climate change.



Given the situation that not all sites used by elephant can be of conservation, which sites are of priority for future conservation: at last, this planning activity has shown that spatial pattern of high or dense populations in scattered locations represent the most favorable habitat and lower sparser populations denote areas of less favorable habitat. Elephant favorable habitat varied in different sites. High valuable sites were found in **A-F-E-D-B** clusters. Less favorable sites were aggregated in **J-K-M.**

Less and high favorable groups are separated by intermediate clusters (**L-O-G-H-C-N**). Hence it is not possible to protect clusters **A** and **F** without **O** and **L**. This leads to the selection of intermediate clusters (**L-O-G-H-C-N)** as connectors of migratory corridors.

Conclusion

Geostatistics are potential tools for prioritization of future elephant conservation habitats. They depict cause-effect interactions within and between habitats in space and time. The use of these tools is beyond conservation priority evaluation but also on predicting species distribution given the mêlée between human and mega- herbivores on adaptation of their practices and strategies to the impacts of climate change, the reason for the need of more research in the Mozambique central ecosystem.

References

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