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Protecting Elephants from Poaching: Case Study of the Application of GIS for Elephants Conservation in Amboseli National Park in Kenya

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***Abstract*—**Kenya Amboseli National Park hosts the largest elephant's population in the country, protected and managed by the government under the Kenya Wildlife Service. The park has been experiencing highly organized poaching, in terms of both total elephant deaths and the level of sophistication employed by the poachers. The main objective of this study is to use GIS to map the entire park properly. GIS map of the park was produced including all leading roads, neighboring land use, main gates and water points with geographic co-ordinates well documented. The result obtained indicates the three main gates and the airport as the hotspot points that the tusks can be ferried out of the park. Therefore, this study recommends the government to put strong security measures on these areas. These procedures can lower the poaching threat and assist the game warders properly manage the endangered species.

***Keywords*—**Elephants, GIS, poaching, Amboseli National Park.

I. Introduction

ELEPHANT poaching and ivory trade are unlawful in Kenya and pose a major risk to elephant's population in the country. In only 1970s more than 1900 elephants were killed the number hiked to 8300 elephants in the 1980s until 1990 when Kenyan president Moi convinced the world to stop the ivory trade in Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). In 2006 dramatic rise has been noticed again, between 2007 and 2010 seven-fold increase have been also recorded [1]. During colonial era, elephant poaching was hoppy and sporting activity for noblemen. However, primary purpose of some hunters was for ivory to sell to get money and meat to meet their basic needs [2]. Furthermore, to spice the ivory trade, in only 1963 government issued 393 licenses to hunters which greatly reduced the population from 275,000 in 1970 to 20,000 in 1989 [3]. In 1990s, the worldwide ban on ivory trade stabilised the elephant population; howsoever, illegal poaching and black market are another challenge facing the species. The worst poaching event in Kenya was seen in January 2013, when a family of twelve elephants were killed [4].

Although elephant hunting has been banned globally for more than 40 years now, in Kenya still poaching has not decreased due to poverty, high return associated to elephant tasks and easy shipping to the ready black market. For the fact Kenya has several national parks and game reserves to conserve wildlife but still elephant's population is at stake and the pathetic situation is exacerbated by corruption and political positions [6]. The reason behind the elephant poaching is number one the price of their tusks, which grow from their skull without skeletal support, and that are not horns. It is composed of a material known as keratin, which can also be found in skin, hair and fingernails. The tusks are believed to have medicinal values where they are grinded and drank; because they (tusks) 'cure all' medicine, for anything from smallpox to evil spirits although not scientifically proven. Elephants tusks are also symbol of high social status, with only the very wealthy capable to afford the large price associated to it. It is predominantly vital that a well-resourced and cohesive effort like GIS to protect elephants is brought into place because demand for poached elephants may increase exponentially. As the poachers' income continues to go up their size and spending power will also rise and as demand increases more sophisticated poaching operations will also be developed.

Fig. 1 The 12 elephant family that were killed [5]

Benefits of Kenya elephant are shown in the marketplaces, like tourist payments on elephant site viewing, or even trophy hunting; more so the ivory value, although banned. However, not easy to quantify the exact economic contribution but Kenya's GDP approximately 12% is contributed by elephant's tourism in one way or another. Though, there is no specific or particular study on the economic value contribution of only elephants in Kenya but there are other reports and works related that have been done in other parts of Africa like Botswana, Zimbabwe, and Namibia that betokens an increase in the relative contribution of non-consumptive benefits to the economic values of elephants, but a decline in the overall

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economic value derived from elephants after the CITES veto on trading in elephant products [7]. There is still elephant damage, in Kenya which was estimated that benchmark damage costs to the Maasai amounted to US$2 470 km^{-2} per year ranging from local communities' crops, water points, killing of livestock and human beings and infrastructure destruction but still negligible and can be controlled with proper management and technology use. The correct function of institutional achievement is no doubt a prerequisite for the actual internalisation of damages [8].

There are various factors that forces this study to use GIS to protect the elephants, number one is sustainability and to preserve it for future generations; the ecological importance they play in the ecosystems; and also people need to have the choice to enjoy profits from them in future and moreover, economic generation to the country at large [7]. The readiness to pay to preserve elephants for future generations on the part of many people, who may never even see an elephant in their lifetimes, is generally only partially captured through donations and thus largely remains unexpressed. An interpretation of economic value thus goes beyond exchange values as measured through market-based transactions. Generally Kenyan economy is thriving due to tourists' attraction and due to that, the earnings of even the local communities are improved directly or indirectly through job opportunities and tour guide activities. Tourists pay big amount of money to see an elephants tramping amid the lush of Kenya national parks [9] and no doubt tourists won't, however, pay to see a rotting elephant carcass engulfed by flies and other insects, its tusks removed by poachers. Once poachers know that conservation can be done through technologies like GIS, they will start to think about trapped by the system location and will not attempt poaching again.

This GIS study targets to provide relevant geographical information to the Kenya Wildlife Services and Kenya Tourism Board, that strict policy method towards raising awareness on poaching can be established, educational programs and awareness campaigns can be developed for locals specially the Maasai communities, non-governmental organizations, national and international governments. The GIS idea developed here will be loaded in the conservation websites in the country, the way forward as presented on this document will be part of the country's exhibition to create sensitization, and the final results of this article will be published in the mainstream media both locally and internationally to safeguard the rare important species. Demonstrations and presentations will be planned for the government of Kenya and international animal health, and wildlife conservation organizations in the near future if possible.

Ready market for ivory in China, Vietnam and Thailand is empowering Africa's increasing elephants poaching and conservation institutions foresee the ivory demand will make elephants to be extinct [10]. However, not only in Kenya but entire Africa, elephant poaching is reaching at a critical level because tens of thousands of elephants are killed in every lunar year.

Research works have indicated that demand for ivory is going high every year in these countries with a growing middle class - and other Asian end-markets and when that happens, nothing will stop poachers to get the precious item howsoever, demand for ivory is a global challenge: from the United States, to Europe, to South America, to Asia, to the entire Africa continent there are ready consumers willing to shell out any time. Presently ivory on the black market in China is trading a kilo for about $3000 dollars, tusks can grow to in excess of 60kg (the largest ever recorded was 102.7kg) making the possible return for tusks extremely high [11].

It has been a normal case in Kenya to hear about poaching, but it has never been as serious as it is in these recent years. Only last years, tens of thousands of Africa's elephants have been maimed to feed illegal ivory markets throughout the globe. Surprisingly, economy generated from these painful elephants poaching activities may be used to fund war and terrorism in Kenya and other parts of Africa or anywhere in the globe. This study targets to help minimize illegal elephants poaching fiasco which is turning to be a big business. In 2013, illegal poaching inclusive of elephants poaching was estimated to be $17 billion dollars a year and growing. The common poaching weapon in Kenya is AK47 [11] however, sophisticated and advanced poachers spot elephant herds from helicopter and shoot their prey from the air and on-the-ground poachers use machetes, spears and watermelons laced with cyanide and other poisonous chemicals [12]. Kenya's policy for legal guns a rifle is going for about $100-120 which is just a low fraction for elephant poachers compared to the profits they make from black market and to spice it all, government allowed tusks to be removed from old or sick or dying elephants and the opportunity is used by licenced people to kill healthy, strong and trumping elephants.

Fig. 2 2.1 tonnes of ivory seized in Mombasa Kenya displayed by Kenya Wildlife Service [13]

A survey has shown that 70% of the people said tusks of elephants they grow back like fingernails. Another group believed that elephants' tusks fall out naturally. According to animal rights individuals, it is estimated between 25,000 and 35,000 elephants are killed annually in Africa which means around 104 die per day. In addition, negligence of Kenyan government is another clear indication because, out of 157

cases of elephant poaching cases in the last 3 years less than 5% have been prosecuted or jailed [14].

November 5, 2013, Obama administration destroyed about 6 tons of 'blood ivory' which sent strong message to the world poachers and ivory illegal trade and the same should be tried in Kenya with all possibilities employed including GIS and other technologies. Surely, the world and human beings in particular have to treat elephants and all animals with respect because they a living and love to live like us [10]. Therefore, purpose of this study is to produce a three-dimensional digitized base map that would serve as an important foundation for a variety of more sophisticated analysis concerning the relationships between the park elephant poaching, neighbouring land use, roads, streets, airports and water sources where all are properly mapped to help the management to reduce the poaching menace.

Fig. 3 Brought to its knees: The elephant had succumbed to the poison arrow which poachers had fired into its hind leg [14]

Fig.4 Kenyan Map showing Amboseli National Park (Study Area Circled Red) [16]

The specific objective of this study is to identify suitable criteria for siting poaching hotspots in the park and apply this set of criteria using GIS to locate such areas.

II. Description of the Study Area

Amboseli National Park is in the heart of Loitoktok in Kajiado District, Rift Valley Province of Kenya. The park was previously known as Maasai Amboseli Game Reserve. It covers 39,206 hectares (392 km^{-2} 151 sq mi) at the core of

8,000 square kilometres (3,100 sq mi) with an average rainfall 350 mm. The park safeguards two of the five main swamps that include a dried-up Pleistocene lake and semi-arid vegetation. It's located 240 kilometres (150 miles) southeast from the capital city Nairobi, Amboseli National Park is the second most popular national park in Kenya after Maasai Mara National Reserve. The ecosystem of the park spreads to Kenya-Tanzania border dominated by savannah grassland. It's also the best place in Africa tourism due to the free-ranging elephants among other wildlife species with 400 species of birds including water birds, pelicans, kingfishers, crakes, hamerkops and 47 other different types of raptor. The park is neighbouring cultural conservative Maasai pastoralists but people from other parts of the country have settled there attracted by the successful tourist-driven economy and intensive agriculture along the system of swamps and beauty views of the eminent Mount Kilimanjaro [15].

III. Methodology

The Google earth map available online data was used to result in a single image set. The visual interpretation was performed on different ways to identify the land use, buffer zones, neighbouring pastoral land and also roads and streets leading to the area which the poachers use to access the park. The result obtained was digitally encoded in GIS database as needed. The comparison of the different features of interest was processed by overlay functions of the GIS. The study used a colour composite of three bands which are red (representing gates and airport) , light green (representing neighbouring land use) and blue (representing water services) and the result has helped to differentiate various areas in the park. The geo-referenced map was digitally enhanced to give better discrimination and vision. The map generated was prepared with reference to the topography map as available at approximately 1:200000 scale. The map attribute data was also digitised encoded in the GIS database that finally generated land use of the neighbouring areas, road and streets, airport and water points in the park where they were properly demarcated. In addition, the geo-information resulting the basis for the establishment of the neighbouring land use, roads and streets, airport and the water sources were mapped, digitised and encoded in the GIS database [17].

The data sources were derived from Google earth, IUCN (International Union for Conservation of Nature) available data and topographic maps of the country is used for geo-referencing and supplement information.

IV. Result and Discussions

Figs. 5-10 are maps showing relationships and interactions between various neighbouring land use, roads and streets, lakes (water sources), and airport, main gates and the international boundaries within or near the park which are well digitised and georeferenced and the possible hotspots or dangerous areas were designated with red marks on the map. The Amboseli national park, which lies in the middle of the group ranch, is government owned land. The group ranch itself is under group tenure and the light green area shows pastoral and nomadic land use (sections of group ranch that have been subdivided and sold to individuals). It is observed that private land (neighbouring land use) is a dangerous zones that can host poachers during drought seasons when the pastoralists search for water and pasture in the park. Private land owned by individuals also blocks the buffer zones of the park.

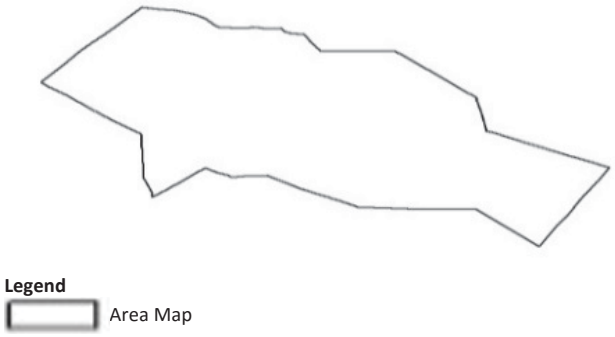

Fig. 5 Complete digitised and Geo-referenced Amboseli base map

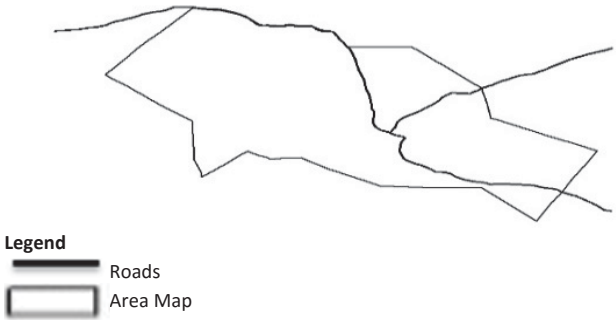

Fig. 6 Complete digitised and Geo-referenced Amboseli Main Roads

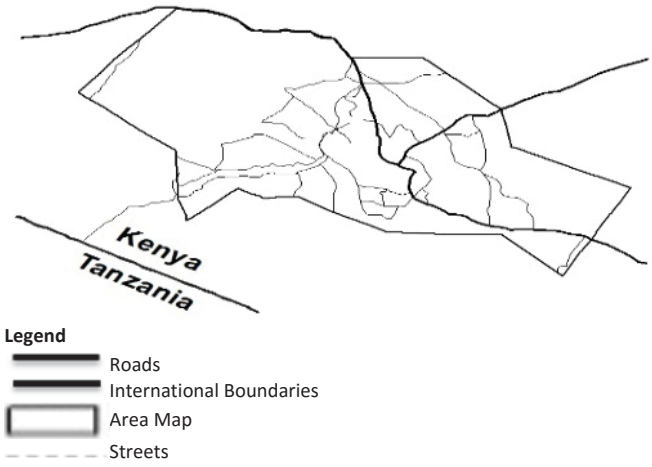

Fig. 7 Complete digitised and Geo-referenced Amboseli map showing Streets, Roads and International Boundaries

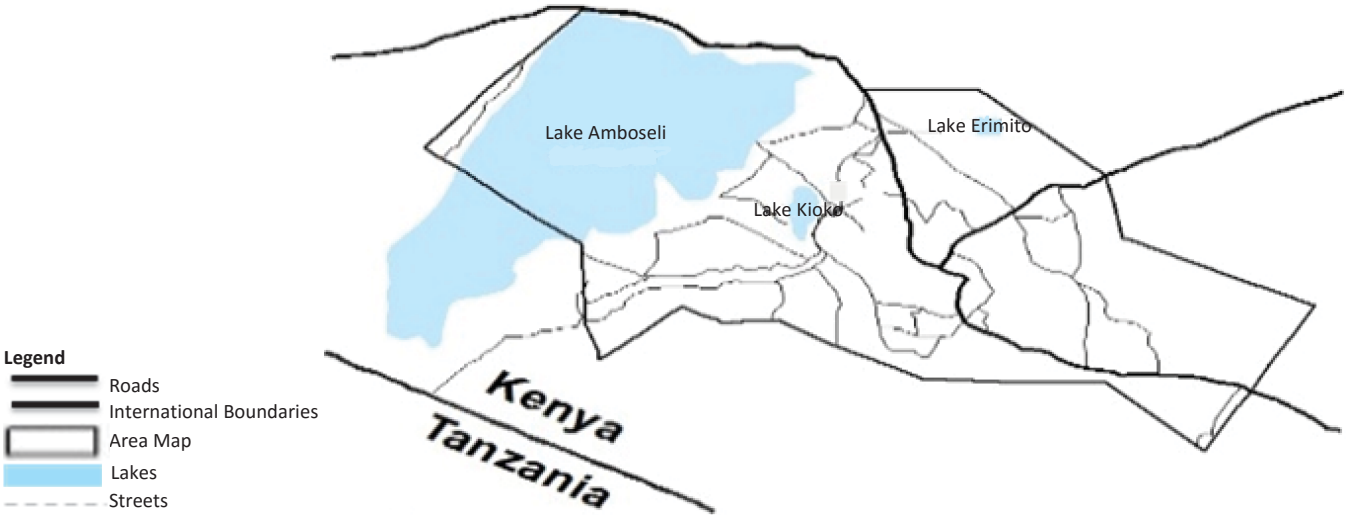

Fig. 8 Complete digitised and Geo-referenced Amboseli map showing Streets, Roads, Lakes and International Boundaries

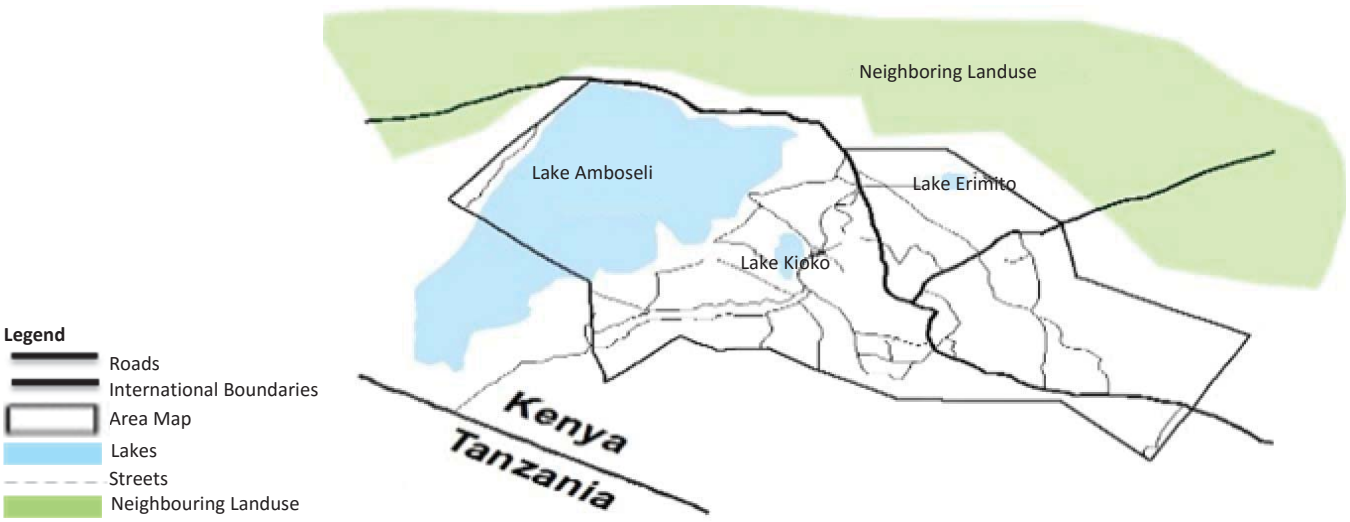

Fig. 9 Complete digitised and Geo-referenced Amboseli map showing streets, roads, neighbouring land use and international boundaries

The other important feature in the study noted is the use or roads, streets and airport which can be easily used by the poachers to furry the tusks from the park.

V. Conclusion and Recommendations

If the variants of data above were viewed discretely, it would not be facile to pinpoint possible hotspots and perilous areas. But, by visually examining it holistically, it is possible to visually perceive that land use from nomadic grazing to sedentary agriculture, which has led to subdivision of land, has subsequently led to blockage of some of the prominent wildlife migration routes in the area and allowed free movement in and out of the park during drought seasons in search of pasture and water. The finding is also in line with work done by Baldwin and his team who used GIS and found that land use has greater influence on natural resource conservation [18]. The other important areas pointed as very dangerous are the airport, roads and streets for easy transportation. Therefore, this study recommends those government agencies and other organizations dealing with wildlife conservation and land use policies, in Kenya, make increased and effective use of GIS technology for improved conservation and enhanced decision making. The same was noted by Yuri and his group [19]. Strong security measures to be placed on the four main gates (Kitirua gate, Erimito gate, Meshanani gate and Kimana gate), regulate the traffic flow on the roads leading to the park and the airport to search the transported loads. Furthermore, the study recommends the government to monitor pastoralists' movement in and out of the park during drought seasons.

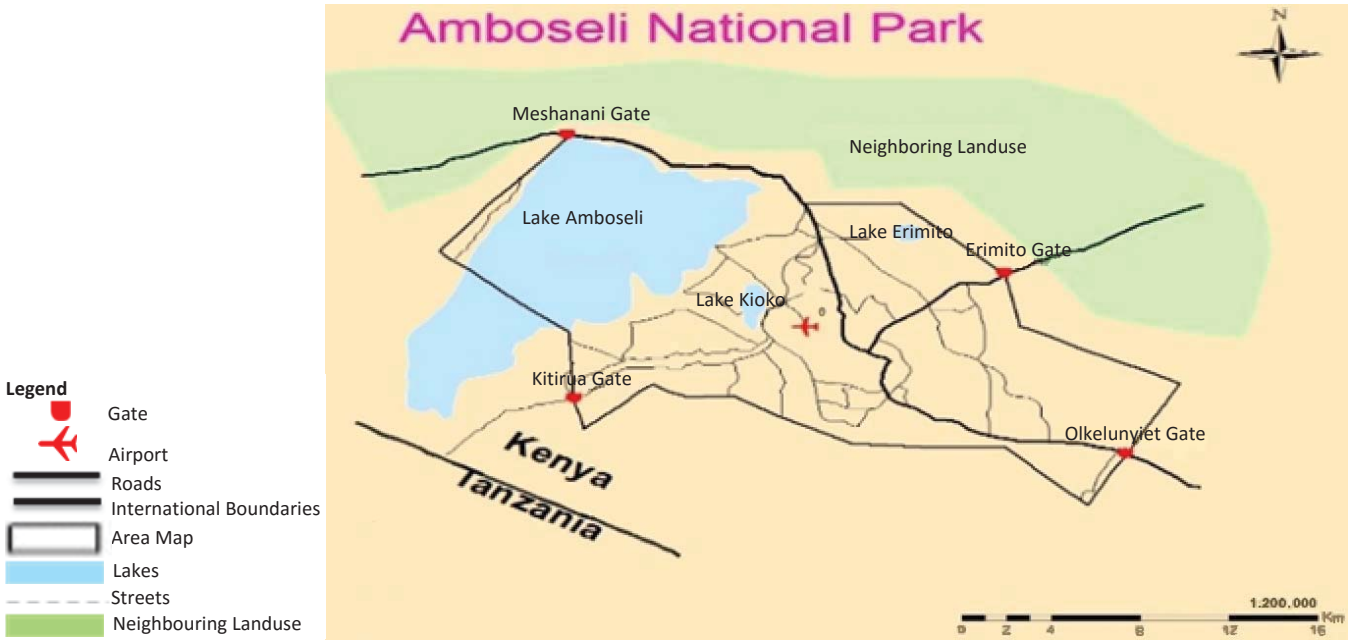

Fig. 10 Amboseli National Park showing digitised and geo-referenced roads, streets, Neighbouring land use, water sources and the park Airport

In conclusion, with GIS data the periodical monitoring, protection and conservation of Amboseli national park can be effectively undertaken to minimize elephants poaching. The GIS elephant's anti-poaching program and elephants protection should be carried out on a sustainable basis using appropriate and effective measures in accordance with present computer based GIS with updated satellite data which offers the spatial information relevant to the effective measures to minimize the alarming elephants poaching threat in the national park. More analysis can be done as this work only provides better base map and further, study can be carried out if the necessary data are available in the right format and standard. Related work was also done by Clark and his team who used GIS to map and conserve yellow eyed-penguin in New Zealand [20]. Additional criteria can as well be added easily as more information becomes available. The authors recommend the Kenyan government to take exigent action to stop conflicting land use/ land tenure along wildlife migration corridors, not only in the area of study but with all other wildlife migration corridors such as the ones between the Maasai Mara in Kenya and Serengeti in Tanzania to enable sundry ecosystems to sustain both man and wildlife. This study is in agreement with other studies done to conserve, maintain and sustain natural resource [17]–[23].

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