بسم الله الرحمن الرحيم

Sudan University of Science and Technology

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Degradation of Biodiversity at Dinder National park - Sudan

تدهور التنوع الحيوي بمحمية الدندر القومية – السودان

By

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بسم الله الرحمن الرحيم

Dedication

To All Who Love

Prophet Mohammed

لكل أحباب المصطفى

صلى الله عليه وسلم

Acknowledgement

I am fully indebted to my supervisor **Prof. Dr. Ibrahim Mohammed Hashim** for his valuable efforts, guidance, helpful, and continuous encouragement during the research period. Thanks are due to Ayuob Nour Aldeen and KHalda Soluman and Mubarak Ali Ibrahim who have provided valuable assistance and suggestions that helped in improving and completion of this work.

I would like to express my gratitude to all those who assisted me to complete this thesis.

المستخلص

تدهور التنوع الأحيائى في حظيرة الدندر القومية ، بسبب الاستخدام غير المستدام للموارد الطبيعية ، صار مشكلة كبيرة الآن .

تهدف هذه الدراسة إلى تقييم العوامل التي تسبب تدهور التنوع الاحيائى وتبني تدابير لتخفيف التدهور ، جمعت البيانات الثانوية من التقارير السنوية من مركز بحوث الحياة البرية والإدارة العامة للحياة البرية، واطروحات الماجستير والدكتوراه من مختلف المؤسسات، ولا سيما مركز بحوث الحياة البرية، جامعة بحري، وجامعة السودان للعلوم والتكنولوجيا، وكذلك من الأوراق المنشورة.

جمعت المعلومات ابتداءاً من ديسمبر– يناير 2017/2016 حتى مايو 2017 . حللت المعلومات وفسرت من أجل تحقيق أهداف البحث .

أظهرت النتائج ثلاثة نظم أيكولوجية فى الحظيرة : الميعات ، والضهرة والنظام النهري . وكل نظام بيئى يتميز بنوعية من ألاشجار والشجيرات بالرغم من أن وفرتهما تختلف فى كل نظام . والميعة في الغالب تكون مغمورة بالمياه خلال موسم الجفاف، وتغطيها عشبيات كثيفة منخفضة النمو.

الثديات الصغيرة لا تنتشر عشوائياً فى النظم البيئية للمحمية . انقرضت بعض الثديات الكبيرة مثل غزال سنجة وتيتل تورا والزراف وتيتل تيانق. والعوامل التي تؤثر على تدهور التنوع الأحيائي هي الصيد الجائر ، والحرائق ، وقطع الأشجار، وصيد الأسماك والرعي الجائر.

Abstract

Biodiversity degradation due to unsustainable use of natural resources in Dinder National Park is now a big problem. Objectives of this study are to evaluate the factors that cause biodiversity degradation and to adopt mitigation measures. Secondary data was collected from: annual reports from Wild Life Research Center and Wildlife Conservation General Administration; M.Sc. and PhD theses from various institutions, particularly the Wildlife Research Center, University of Bahri, and Sudan University of Science and Technology; Published Work. Data collection started from December-January 2016/2017 until May 2017. Data was analyzed and interpreted to attain the objectives of the study

The findings were that the park comprises three ecosystems: Mayas, Dehra and Riverine. Each ecosystem has its own characteristic trees and shrubs species though the abundance of these vary in each ecosystem. The Mayas are mostly wet during the dry season, and densely covered with low-growing herbaceous vegetation.

The small mammals are not randomly distributed in the ecosystems. Some large mammals like Soemmering's gazelle, (*Gazella soemmeringii*), tiang, tora hartebeest (*Alcelaphus buselaphus tora***)** and Giraffe (*Giraffa Camelopardalis)* are exterminated in the park. Factors affecting biodiversity degradation are poaching, wild fires, tree felling, fishing and livestock trespassing into the park.

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CHAPTER ONE

INTRODUCTION

1.1. Introduction

Degradation is a process of turning the productive land, be it arid, semi-arid or sub-humid, into desert, involving series of changes, from slight to very severe changes of plants and soil resources due to man's activities and climatic change (UNEP, 1991; Zhang et al, 2008). In addition, Urbanization coupled with the loss of fertile soils, over-exploitation of water resource, over-grazing, destruction of natural vegetation and rapid land use changes are the factors leading to environmental problems.

Due to the combination of the factors involved over time and in various geographic locations, temperature may rise, causing negative impact such as water stress and food shortage; Libya in North Africa is experiencing such a problem (IPCC, 2007; MEA, 2005). Most North African countries lie within the warm desert climate zone where the desert covers 98% of the territories (Emgaili, 1995).

The unique biodiversity of various geographical areas is being lost on scale that is quite unprecedented even though tropical rainforests make up just 6 percent of the surface area of the earth on which about 85 percent of the entire species of the world exist (Emgaili, 1995). Biodiversity is being lost rapidly so massive species extinction is eminent. Factors involved in the potential extinction include the following:

1.1.1 Poaching

Poaching is considered a determining factor of animal extinction, particularly some species like Dorcas gazelle (*Gazella dorcas*) the African elephant (*Loxodonta Africana*), raptors, whales and turtles, leading to a decrease in the

numbers of these animals, and they are threatened with extinction. In addition, the low reproductive rate of long-lived animals (elephants, turtles, raptors), complicates the problem.

1.1.2 Overgrazing

Plant species are severely affected by overgrazing. Poor rains in most desert areas in Arab countries coupled with overgrazing for a short or a long period of time at a fixed area of the pasture leads to deterioration of plant species, loss of their ability to grow again, and also deterioration is caused by lack of rain for several consecutive years. (1995،كيمبل بيولوجي / جون وكيمبال)علم حياة الانسان د.عايش زيتون).

1.1.3 Felling of trees

Felling of trees has a direct impact on the forest, leading to extinction of tree species. In Sudan, for example, the area between latitudes 15º - 13º N, was dense with trees that were removed due shifting cultivation. Exposure of the area to the northern dry winds led to soil degradation, so the vegetation cover has become now sparse (Anonymous, 2004).

1.2. Justification:

Sudan, like many other African countries, has been affected by degradation and this caused loss of Biodiversity. Biodiversity is the real wealth of human beings as it is a source of material, food, pharmaceutical wealth, energy, power, beauty, health, safety, and it is the base to human persistence and its future (Muhyiddin Issa, 2015). Environmental factors, such as forest wild fires, earth quakes, and human factors including depletion of habitat, urbanization, pollution and poaching negatively affected biodiversity to the extent that many species have been exterminated.

1.3. Research problem

Taking Dinder National Park as a case study, degradation in the park is now a big problem due to unsustainable use of natural resources such as over grazing, burning and tree felling. It is important that the impact of these activities be known so that amelioration measures are taken to sustainably conserve biodiversity in the park.

1.4. Objectives

Objectives of this study are to evaluate the factors that cause biodiversity loss and to adopt the measures that lead to biodiversity conservation in Dinder National park.

1.5. Climate

The park annually experiences wet and dry seasons. The annual rainfall varies from 600 to 700 mm. The rains start in June and September or October.

Temperature ranges from 30º- 45°C. However, temperature varies from 20°-30º C. In the dry season, cool nights and warm days are experienced from November – March (Hakim et al, 1979).

1.6. The Soil

Dinder National park is dominated by heavy, dark cracking clays (cotton soil or vertisols) within which sandy clay and sandy loam (entisols) are interspersed. Vertisols are largely alluvial in origin, and are made up of materials transported from the Ethiopian highlands. They contain above 60% clay and are alkaline with PH around 9 (Dasmann1972, Dai 1982). This soil shrinks at the dry period, producing wide, deep cracks. The sandy soil (entisols), on the other hand, is mostly common close to Sudan – Ethiopian border and along the Dinder and Rahad rivers (Minga. 1971).

CHAPTER TWO

MATERIAL AND METHODS

2.1 Study area:

Dinder National Pak lies in the southeastern portion of Sudan, bordering Ethiopia (Fig. 1), extending from 26° 12' N to 42° 12N' and 48º 34' E to 35o 20' E. Embracing 10292 km²; the park has been declared as protected area since early 1935. It is mainly drained by Rahad, Dinder and Galego Rivers, and it lies mostly in Sennar State and partially in Gadaref State.

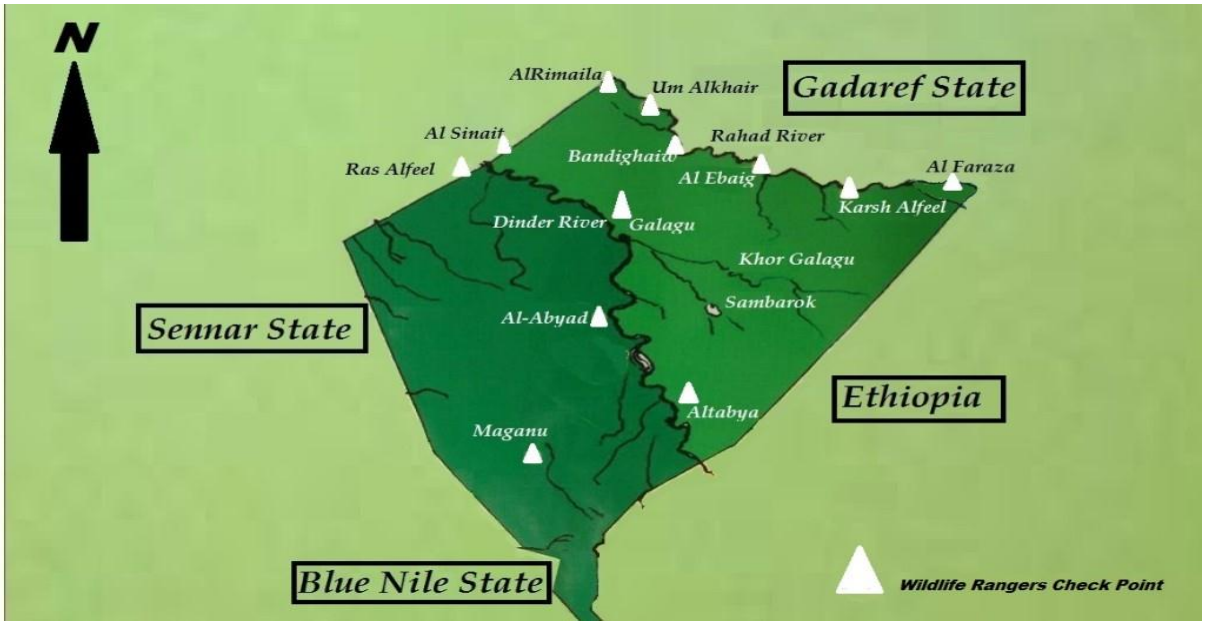

Figure 1 : location of Dinder National Park (Source: wikipedia.org).

The climatic year is divided into pronounced wet and dry periods.

The dry period extends from November until May when the temperature reaches its maximum level. Both Soil and vegetation become progressively drier during the dry period. The vegetation is adapted to the high temperatures as shown by the deciduous habits of most trees and the ephemeral life of herbs and grasses (Dai, 1982). Water in the park becomes scarce during the dry period and is restricted to small pools along the beds of River Dinder and

Khors Galego and in some of the *Mayas* (meadows) (Holsworth,1968), where the wild animals aggregate.

The wet period usually extends from June through October. The rainfall during this period is highest in the southeasterly portion of the park and becomes progressively low as the distance increases northwest (Dasmann, 1972). The temperature drops during this season and Rahad and Dinder rivers start flowing in July, reaching their peak flow in September. The annual mean relative humidity varies between 35% - 45%, but higher value as 79% was recorded during the peak of the rains in August (Dai, 1982).

The average annual rainfall ranges from 600 mm to 800 mm, the daily maximum temperature from 42º – 40º C in the dry period and 42ºC - 40ºC in the rainy period.

The park is dominated by heavy, dark cracking clay (cotton soil or vertisols) within which sandy clay and sandy loan (entisols) are interspersed. Vertisols are largely alluvial in origin, and are made up of materials transported from the Ethiopian highlands. They contain 60% clay and are alkaline with pH around 9 (Dasmann 1972, Dai 1982). The soil shrinks at the dry period, producing wide, deep cracks. The sandy soil (entisols) on the other hand is mostly common close to Sudan-Ethiopian border and along the Dinder and Rahad rivers (Minga, 1971).

2.2 Research Methodology

2.2.1 Data collection

Secondary data was collected from: annual reports of wildlife Research center and Wildlife Conservation General Administration; M.Sc. and Ph.D. theses in various institutions, particularly the Wildlife Research Center, University of Bahri, and Sudan University of Science and Technology;

Published Work; and form the internet. Data collection started December-January 2016/2017 until May 2017.

Data was analyzed and interpreted to attain the objectives of the study that:

Factors negatively affecting biodiversity would be identified and mitigation measures for these factors would be suggested; Future plans to conserve biodiversity sustainably would be developed.

CHAPTER THREE

RESULTS AND DISCUSSION

3.1 Biodiversity

3.1.1 Vegetation

Much work has been done on vegetation of Dinder National Park, classifying it into three types: grassland, wood and Riverine forest. The western parts of the park fall within Acacia seyal-Balanites-Savannah ecological zone with grass areas (Harrison and Jackson, 1958, Smith 1949).

Hakim and Fadlla (1978) divided the park into three ecosystems – namely, *Dehra,* Riverine and *Mayas,* the *Dahra* ecosystem lies within the *Acacia seyal - Balanites aegyptiaca* ecological zone and occurs extensively on deep cracking clay soil. The understory vegetation is composed mainly of tall annual grasses with which climbing herbs are intermingled (Fadl Allah, 1982).

Mayas are prominent features of park. They are either sub-irrigated, moist or dry, occupy low-laying basins, meanders and oxbows along rivers and *Khors* (Dasmann, 1972). They are important landscapes that dictate animal's distribution in the park (Abdel Hameed 1996) by supporting green fodder and water through most of the dry season (FadlAllah, 1982). *Mayas* are also important wetlands for some resident and migratory species of birds and contain diversity of aquatic animals and plants.

The Riverine ecosystem occupies the silt banks of the rivers where Riverine forest dominates. The forest width varies with the width of silt deposits along the river bank, being wider in the north and narrower in the south; the over story vegetation comprises *Hypaene thebaica*, *Stereospermum Kunthianum*, *Acacia seiberana*, (see appendix 1), and the understory vegetation is made up of *Zizphus -spina- christi* and *Gardinia* spp. (Hakim 1978).

The *Maya* vegetation comprises grasses and grass-like, forbs and shrubs (Appendix 2). Based on their mesic and xeric condition, the *Mayas* were classified into young, productive and old (non- productive) in terms of green forage available for wild animals (Dasmann, 1972; Hashim, 1984). The young Mayas are usually submerged whereas the productive *Mayas* are wet and covered with low- growing vegetation. The old *Mayas*, however, are dry and covered with tall vegetation. Herbaceous vegetation is more diverse in the old *Mayas*, but use made on the vegetation by the wild animals is more intense in the productive *Mayas* (Hashim, 1987a). Minga (1971) noted that the old *Mayas* were preferred by buffalo (*Syncerus caffer*), roan antelope(*Hippotragus equinus)*, bushbuck (*Tragelaphus scriptus*) and gray mongoose (*Herpestes ichneumon*).

The short green vegetation in the middle of the productive *Mayas* is made up of *Cyndon dactylon*, *Typha* spp., *Vossia* spp. and *Echinnocloa* spp. Some older Mayas show a secondary succession trend indicated by an increase in tree species, particularly *A. seiberana* and *Acacia nilotica* (Hakim, 1978).

3.2 Herbaceous vegetation cover:

During the dry season, most of the park area is either burnt or covered by litter that dominated the Dehra, Riverine and Maya. Litter is high in the Riverine followed by Dehra but relatively low in the Mayas. The burnt area is small in the Riverine and Maya but is considerably large in Dehra (Mahgoub 2004). ELtom (1982) notes that the Riverine ecosystem is least affected by fire because it is moist and the Mayas became susceptible to fire when they dry up.

The size of bare soil is higher in Riverine compared with Dehra and Maya, probably due to the dense crown cover of trees in the Riverine ecosystem that hinders sunlight from penetrating to the ground and thereby reducing herbaceous plant growth.

Dense herbaceous vegetation cover occurs in the Mayas, negligible in Dehra and Riverine ecosystems. The Mayas are mostly wet during the dry season, and densely covered with low-growing herbaceous vegetation.

About 38% of the parks area is burnt in the dry season (Mahgoub 1991).

However, Holsworth (1968) suggests that 85% to 90% of the grassland in the park is burned yearly, and Hakim (1978) reports a figure of 75%. Dasmann (1972) noticed that large portion of the park had already been burnt when he conducted his study. Minga (1971) reported that the burning was due to nomads, poachers and resource collectors. Sometimes the wildlife personnel burn large portion of the park during the opening of the roads at the beginning of the dry season.

3.3 Overstorey vegetation:

Table 1: Density of trees in ecosystems of Dinder National Park

No.	Tree species	Density (tree/h) in		
		Dehra	Riverine	Maya
1	*Acacia seyal* (Taleh)	105.5	22.8	0
2	*Combertum glutinosum* (Habeil)	40.7	4.0	0
3	*Acacia camplycantha* (kakamout)	15.1	7.0	0
4	*Balainites aegyptiaca* (Heglig)	13.4	9.0	0
5	*Terminalia laxiflora* (sobag)	12.4	0.2	0
6	*Ziziphus spina-christi* (seder)	9.4	21	0.5
7	*Acacia sieberana* (kuk)	4.6	15.7	1.0
8	*Stereospermum kunthianum* (khashkhash)	3.1	4.4	0
9	*Piliostigma reticulaum* (kharoub)	2.2	11.6	0
10	*Salix subserrafa* (Guiar)	1.6	0.1	0
11	*Combertum aculeatum* (shohiet)	1	19.3	0
12	*Acacia senegal* (hashab)	1	0.2	0
13	*Terminalia brownie* (Darot)	.7	0	0
14	*Grewia molts* (Bashum)	.3	.04	0
15	*Crateva adansonii* (Dabker)	.3	1.0	5.7
16	*Acacia nilotica* (Sunot)	.2	2.0	5.2
17	*Lannea schimperi* (melees)	.1	0	0
18	*Gardenia* sp. (abungawee)	.1	0.9	0
19	*Boscia angustifolia* (Sereh)	.2	0.4	0
20	*Dichrestachys cinerea* (kaddad	0.02	0.07	0
21	*Albizia alymeri* (serrier)	0.2	0.07	0
22	*Capparis tomentosa* (Gulum)	0.02	0.3	0
23	*Zizphus mucronata* (Nabag Elfeel)	0.2	0.4	3.0
24	*Bascia senegalensis* (kursan)	0	0.4	0
25	*Hyphaenea thebeica* (Dom)	0	10.8	0
26	*Lonchocarpus laxiforus* (Harhar)	0	0.2	0
27	*Enrada sudanica* (liuom)	0	1.0	0
28	*Omsemema*	0	.04	0
29	*Combretum* sp. (om esmail)	0	0.2	0
30	*Combretum* sp. (shabah Elhabiel)	0	.04	0
31	*Anogeissus leiocarpus* (sahub)	0	0.1	0
32	*Tamarindus indica* (Aradeb)	0	0.2	0
33	*Momordica balsamia* (Abuelefeen)	0	0.3	0
34	*Dalbergia melanoxlon* (Abanoos)	0	2.3	0
35	*Ficus cycamorus* (Gumiez)	0	0.3	0
36	*Mytenus senegalensis* (yoii)	0	.04	0
37	*Mimosa pigra* (shagrat Elfaas	0	0	6.2

Source: Mahgoub (1991).

Thirty-eight species of over story vegetation were recorded in the Dehra, Riverine and Maya ecosystems of Dinder National Park (Table 1, see also Appendix 1). Each ecosystem had its own characteristic trees and shrubs species though these could be less abundant in other ecosystems. The Dehra ecosystem is dominated by *Acacia seyal*, *Combertum glutinosum*, *Acacia complycantha*, *Balinites aegyptiaca* and *Terminalia laxiflora*, and these species were also found to a lesser extent in Dehra-Riverine ecotone. The Riverine ecosystem is dominated by *Ziziphus -spina-christi*, *Acacia sieberana*, *Piliostigma reticulaum*, *Combertum aculeatum* and *Hyphaenea thebeica*, with traces of these in the Riverine-Dehra ecotone. The Maya ecosystem is devoid of trees and shrubs except *Crateva adansonii*, *Acacia nilotica*, *Mimosa pigra* with traces of the former two species occurring in Maya-Dehra ecotone.

3.4 Mammals

3.4.1 Small mammals

Abundance and distribution of small mammals was assessed in Dinder National Park by animal capture, animal signs and night surveys.

Nineteen mammalians species were identified (Table 2), these were seen (36.9%), captured (52.6%) or identified by signs (10.5%).

Table 2: Small mammals positively identified in Dinder National park, during period January to May 2002.

Common name	Scientific name	Family
Shrew	*Crocidura* Sp.*	Soricidae
Unstriped grass rat	*Arvicanthis niloticus**	Muridae
Spiny mouse	*Acomys hunter**	Muridae
Yellow – winged bat	*Lavia forns* +	Nycteridae
Silt – faced bat	*Nycteris* Sp.*	Nycteridae
White – tailed mongoose	*Lchneumia albicanda*+	Herpestidae
Egyptian mongoose	*Herpestes lchneumon**	Herpestidae
Common genet	*Genetta genetta dongolana*	Viverridae
Servaline genet	*Genetta Servalina bettoni* +	Viverridae
Serval cat	*Felis serval**	Felidae
African civet	*Civettictis civetta**	Viverridae
Wild cat	*Felis* Sp. +	Felidae
Ratel	*Mellivora capensis**	
Fox	*Vulpes* sp. +	Canidae
Striped ground squirrel	*Euxerus erythropus* +	Xerini
Senegal Galago	*Galago senegalensis* +	Galagonidae
Crested porcupine	*Hystrix Cristata**	Hystricidae
Rock hyrax	*Procavia* sp. -	Hyracoidae
Aardvark	*Orycttеropus afer* -	Orycteropodidae

Animal are either seen (+), captured (*) or identified by signs (-) (Source: Mahgoub and Hashim 1996).

The small mammals were not randomly distributed in the park; they were concentrated between latitudes 12° $30'$ and 12° 45° where more animals occur at the western side of Dinder River close to the park headquarter than the eastern side for two reason: 1) the area surrounding the park headquarters was

less disturbed compared with the remote parts; 2) there was a favorable vegetation cover in the vicinity of headquarter compared to the remote parts of the park because wild fires rarely happen around the headquarter. (Mahgoub, 2005).

3.4.2 Larger mammals

Larger mammals inhabiting Dinder National Park (Appendix 3) fall into 11 families comprising 23 species. The eight extant species in the family Bovidae are roan antelope, waterbuck, reedbuck; greater kudu, bushbuck, Oribi and Heuglin's gazelle; and the exterminated species are the Soemmering's gazelle, tiang and tora hartebeest (Scientific names in Appendix 3). Cercopithecedidae and Canidae each contained three species; those in the first family are baboon, patas monkey and grivet monkey, in the second family black-backed jackal, common jackal and the wild dog. Hyaenidae embraces Spotted hyaena and Striped Hyaena. The remaining families—Suidae, Felidae, Giraffidae, and Elephantidae each is represented by one species. Respective species of these families are warthog, lion, giraffe, and elephant. The giraffe is exterminated in the 1980's and the elephant visits the park only during the rainy season in October.

3.5 Factors Affecting Biodiversity

3.5.1 Poaching

Poaching and fishing inside the park are common activities, both in wet and dry season. The inhabitants of Magano village which lies at the extreme southwest of the park hunt small animals like Rock hyrax (*proavia capensis*), porcupine (*Hstrix cristata*), guinea fowls (*Numida meleagris*), and cane rat (*Rattus norregicus*).This is done more or less at a subsistence level because their customs and rituals are very rich with myth related to wild animals

(Anonymous, 2004; Hakim, 1987). Several researchers (Esaly, 1988, Fadllmola, 199, Albadwy 2000, Anonymous 2004, Mahgoub 1991, Elmaki 1987, and Abdllateef, 2009) reported that the decline of wildlife numbers in park is due to poaching. Anonymous (1998) stated that poaching is more or less related to the park being located in a border area where firearms are readily available and workers at the mechanized agricultural schemes are excellent customers of the bush meat and fish. Therefore, some wildlife species have disappeared from the park, such as Soemmering's gazelle, Tiang, Graffe and Crocodile. Elephants are threatened.

3.6 Fires

Seasonal fires are attributed to cultivators, nomads, charcoal makers, honey collectors, the game scouts (Hakim, 1979) carelessness, cultivation practices, and tick control (Anonymous 2004). Fire damages the perennial grasses, shrubs and some trees, in addition to viable seeds (Abaker, 1985; Anonymous, 2004).

Plate 1: Wild fire in Dindeer Notational Park (Abdalla, Nagi and Hashim, 2016).

Most colonies of honey bees are found in the top parts of trees which need climbing, thus honey collectors cut and burned these trees to collect honey. Intense tree species felling and burning will considerably threaten their survival with the resultant impact on the other animal species that rely on them for food and shelter. Furthermore, the burning by the honey collectors during the dry season initiates wild fires that burn most of the Dinder Park (Mahgoub, 2004; Ibrahim, 2011). Fire damages the perennial grasses, shrubs and some trees, in addition to viable seeds (Abaker, 1985; Anonymous, 2004). This practice is going to continue for a long time because most of the inhabitants practice farming as a main occupation and supplement their income with honey collected from the park (Moilinga, 1996).

The fact that fire has a long history in the park does not mean that its role is necessarily not good. The distribution of vegetation in the park is caused by

repeated wild fire. Ideally, fire can be used as a management tool at certain times and in certain place to achieve the parks objective. Some areas in the park need to be burnt annually to attract animals. Controlled burning removes the heavy accumulated litter that inhabits the growth of seedling. However, uncontrolled, repeated burning could result in the loss of cover and soil erosion (Elgoni 1985) and kills the helpless wildlife species that cannot escape fire (Elgoni 1985).

3.7 Tree felling

Abaker (1982) noted that the local communities cut trees for many reasons, such as obtaining poles used for building huts and browse that is not within the reach of livestock. Felling of trees is also practiced to increase the land under cultivation or for honey collection (Anonymous, 2004). Trees are also cut down for the production of charcoal. The targeted trees are *Acacia* sp, *Balanites aegyptiaca*, *Combretum* spp., and *Anogeisus leucarpus* (Anonymous, 2004; Awad, 1992). Felling of trees will lead to the destruction of woodland habitat of wildlife.

Plate 2: Felling of *Balanies aegyptiaca* in Dinder National Park (Source: Ibrahim M. Hashim, personal communication).

Figure 3: felling of tree for honey collection (source: Abdall, Nagi & Hashim 2016).

3.8 Fishing

Anonymous (2004) reported that local communities practice fishing illegally in the Mayas of the park. Fish is dried and sold in the local markets. The rich merchant and farmers buy most of the dried fish for feeding the laborers at the

agricultural schemes surrounding the park during the rainy season. Sometimes, fishing is done by poisoning of ponds and Mayas in order to obtain the largest stock of fish with minimum efforts (Hakim, 1978). Moreover, the park's administration brings fishermen from villages surrounding the park to harvest fish in most Mayas and sell the product in the local market. The income is used to cover the running cost of the park (Hagar, personal communication). The commercial fishing directly affects fish- eating bird and animals by decreasing the stock of fishes in Mayas, and the continuous presence of fishermen in Mayas or water ponds or pools disturbs wildlife species.

3.9 Livestock trespassing

Abdelhamed (1998) noted that agricultural schemes in the vicinity of the park depleted rangelands so livestock herders are forced to trespass into the park. Many researchers (Esaly, 1988; Fadllmola, 1991; Mordos, 2002; Anonymous, 2004; Zakarea, 2004; Abdllgader, 2005 and Abdllateef, 2009) studied livestock trespassing into the park. Kenyi, (2001) reported that wildlife forces spent most of their time in keeping domestic animals out of the park. Recently, the problem of grazing in the park has become more serious. Special court has been established in Dinder town to deal with park violation. Half of the captured animals will be confiscated and auctioned for the sake of the park Administration but the priority is given to the livestock owner to pay half the price per each head.

Trespassing of the livestock into the park leads to the competition between wildlife and livestock over the park resources, transmission of disease, destruction and change of wildlife habitat (Abdel Hameed 1998).

Although there are laws and regulation restricting and prohibiting all human activities inside the park, some people especially livestock owners do violate

those restrictions and laws on the hope that they can’t be caught or captured because patrolling facilities are limited and law enforcement are ineffective.

CHAPTER FOUR

CONCLUSION & RECOMMENDATIONS

4.1. Conclusion

Dinder National Park is rich with biodiversity; this is eroding very fast due poaching, uncontrolled burning, tree felling, fishing and livestock trespassing. These factors and interactions among them lead to the decrease in some flagship species and extermination of others due to habitat loss and degradation. Ameliorations have been suggested in order to reverse the biodiversity erosion.

4.2. Recommendations

- Recurrent counting for all animal kinds and monitoring of plants in the park is needed in order to ascertain biodiversity trend.
- Fire lines should be established and opened in the park yearly preferably be connected with existing park's network of roads to control wild fires.
- Land use plan in the vicinity of the park should be formulated to ameliorate conflicts in resource uses such as rangelands, cultivation, fire wood and hunting.
- Strict law enforcement is required to protect biodiversity from unsustainable use such as overhunting, overgrazing, tree felling and overfishing.
- Develop water harvesting system at the park, using modern technologies to provide year-round water sources for wildlife.
- Local communities inside and nearby the park should be allowed to participate in the park management, and be allowed access to some resource use in the park which will strengthened its relationship with the park authorities.

- Work to attracting co-tourism to the park, through provision enough honey pot facilities which will help increase incomes for the park and the local communities.
- Attract national and international organizations support long-term biodiversity conservation activities in the park.

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APPENDICES

Appendix 1: Trees and Shrub in Dinder National Park

Family	Scientific name	Local name
Anacardiaceeae	*Lannea fruticosa*	Ghallub
Bignoniaceae	*Stereospermum kunthianum*	Khashkhash
Bombacaeae	*Adansonia digitata*	Tabeldi
Bursevaceae	*Boswellia papyrifera*	Gafal- Tarag tarag
Capparidaceae	*Crateva adansonii*	Dabkar
Caesalpiniaceae	*Bauhinia refescens*	Kulkul
	Piliostigma reticulatum	Abu Khamiera
	Tamarindus indica	Aradeib
Combretaceae	*Anogeissus leiocarpus*	Sahab
	Combretum hartmanum	Subag
	Combretum sp.	
	Terminalia brownie	Darot
	T. laxiflora	Subag
Ebenaceae	*Diospyros mespiliformis*	Jughan
Fabaceae	*Dalbergia melanoxylon*	Abanos
Palme	*Hyphaene thebaica*	Dom
Mimosacea	*Dichrostachys cinerea*	Hurgan, kaddad
	Entada sudanica	Leuon
	Mimosa	Shagarat Elfaaas
Moraceae	*Ficus sycamores*	
	F. capreifolia	Gumize
Rhamnacea	*Ziziphus abyssinica*	Sider
	Z. spina – Christi	Sider
Rubiacea	*Gardeinia lutea*	Abugawi

Source: Holsworth (1968), Dasmann (1971), Awad (1985), Hakim (1978), Hashim (1984), Abdel Hameed (1996),Hashim &Nimir (1979).

Appendix 2. Herbaceous Vegetation in Dinder National Park

Family	Scientific name	Local name
Amaranthaceae	*Achryranthes aspire* *Celosia argentea*	Khashm ElNasieba Danab Elkale
	Ipomaea aquatic	Tamer Elfar
Cyperac eae	*Cyprus sp.* *Eragrotis tremolo* *Killing sp.*	Helio Binnu Seida
Euphorbiaceae	*Jatropha spp.* *Nymhpae sp.*	Khirwa
Graminea	*Andropogan gayanus*	Frow
	Aristida plumose	Ghabash
	A. Spp	Ggieg
	Beckeropsis uniseta	
	Bracharia lata	Furaw
	B. sp	Diffra
	Chloris pilosa	Daz
	C. prieuru	Mileiha
	Cymbopogon nervatus	Hahareeb
	Cynadon spp.	Burtit
	C.dactylon	Nagila
	Dichrostachys Cunerea	Kadad
	Echmochloa sp.	Shelinee
	Hyparrhenia rufa	Burnus
	H. Confinis	Hamerai
	H. pseudocymb	Ansora
	Ischaemum brachyatherum	Gharaz
	Pannicum sp.	
	Pennisetum pedicellatum	Danab Elkalib
	P. ramosum	Karai (dukon)
	Schoenefeldia gracitis	Ghabash
	Setaria incrassate	Halfa
	S.pallidefusca	Clinoab
	Sorghum setigeria	Addar
	S. sudanense	Addar
	S. purpurea- seviceum	Addar
	Sporobolis marginatus	Lukh
	Hibiscus panduniformis	Weika
	H. ficulneus	Bamia khalwia
Nympheaceae	*Nymphaea sp.*	

Tiliaceae	*Corchorus depressus*	Molukhia khalawia
	C. fasciularis	
	C. olilorius	Helio

Source: Holsworth (1968), Dasmana (1997), Awad (1992), Hashim (1984), Awad (1985).

Appendix 3: Larger Mammals of Dinder National park

No	Family	English name	Scientific name
1	Bovidae	1. Roan antelope 2. Water buck 3. Reed Reedbuck 4. Greater Kudu 5. Bush buck 6. Oribi 7. Red-frond Heuglin's gazelle 8. Buffalo	*Hippotragus equinus* *Kobus defassa* *Redunca redunca* *Tragelaphus strepsicero* *TragelaphusScriptus* *Ourebia ourebi* *Gazella rufifrons* *Syncerus caffer*
2	Suidae	9. Warthog	*Phacochoerus aethiopieus*
3	Cercopithecinae	10.Baboon 11.Patas monkey 12.Grivet monkey	*Papio anubis* *Cercopithecus patas* *Cercopithecus aethiops*
4			
5	Hyaenidae	13.Spotted Hyaena 14.Striped Hyaena	*Crouta crocuta* *Hyaena hyaena*
6	Canidae	15.Black-backed jackal 16.Wild dog	*Canis mesomelas* *Lycaon pictus*
7	Felidae	17.Lion	*Panthera leo*
8	Alcelaphini	18.Tiang 19.Tora harthartttebest bees	*Damaliscus lunatus tiang* *Alcelaphus buselaphus tora**
9	Giraffidae	20. Nubian giraffe	*Giraffa camelopardalis**
10		21. Soemmering's gazelle	*Gazella soemmerin,gii**
11	Elephantine	22. Elephant	*Loxodonta Africana+*
12	Rhinocerotidae	23.black Rhino	*Diceros bicornis**
13	Hippopotamidae	24. Hippopotamus	*Hippopotamus**

* extinct + Emigrant (Source: Minga (1971, Dasmann 1972.

Appendix 4. Birds of Dinder National park

Family	English name	Scientific name
ACCIPITRIDAE (Birds of prey)	Black kite. Swallow-tailed kite. Tawny Eagle Lesser spotted Eagle. Martial Eagle. Black-chested Harrier Eagle Snake Eagle. African Fish Eagle. African Hawk Eagle Little sparrow Hawk Shikra. Gabar Goshawk. Dark chanting Goshawk. Pallid Harrier. European marsh Harrier. Harrier Hawk. Long-crested Eagle.	*Milvus migrans.* *Chilictinia riocourii* *Aquila rapax* *Aquila pomarina* *Polemaetus bellicosus* *Circaetus pectoralis* *Circaetus gallicus* *Cuncuma vocifer* *Hieraoetus spilogastei* *Accipiter minullus* *Accipiter badius* *Micronisus Gabar* *Melierax metabates* *Circus macrourus* *Circus aeruginosus* *Polyboroides typus* *Lophoaetus occipitalis*
AEGYPIIDAE	White backed vulture Lappet-faced vulture White-head vulture Hooded vulture Egyptian vulture Ruppell,s vulture	*Pseudogyps africanus* *Torgos tracheliotus* *Tirgonoceps occipitalis* *Necrosyrtes monachus* *Neophron percnopterus* *Gypsruppellii*

ALCEDINIDAE (king fishers)	Malachite kingfisher Grey-headed kingfisher Striped kingfisher Giant kingfisher Pied kingfisher	*Corythornis cristata* *Halcyon leucocephala* *Halcyon chelicuti* *Megaceryle maxima* *Ceryle rudis*
ANATIDAE (Duck, Geese and swans)	Garganey Teal Egyptain Goose Spur-winged Goose Fulvous whistling Duck White-faced whistling Duck Mallard Spur-winged Goose Knob-billed Duck	*Anas querquedule* *Alopochen aegyptiacus* *Plectropterus gambensis* *Dendrocygna bicolor* *D. Viduata* *Anas platyhynchos* *Plectropterus Gambensis* *Sarkidiornis melanotos*
APODIDAE	Palm swift	*Gypsiurus parvus*
ARDEIDAE	Grey Heron Black-headed Heron Goliath Heron Purple Heron Great white Egret Little Egret Squacco Heron Night Heron Yellow-billed Egret	*Ardea cinerea* *Ardea melanocephala* *Ardea goliath* *Ardea purpurea* *Casmerodius albus* *Egretta grazetta* *Ardeola ralloides* *Nycticorax nycticorax* *Mesophoyx metermedius*
BURHINIDAE	Senegal Thicknee	*Burhinus oedicnemus*
CAPRIMULGIDAE	Long-tailed Night jar	*Scotornis climacurus*

	Standards Winged Night jar	*Marcodipteryx Longipennis*
CAPITONIDAE (Barbets and Tinker birds)	Yellow-fronted tinker-bird	*Pogoninulus chrysoeonus*
CHARADRIDAE (Plovers)	Ringed plover Spurwing Plover Egyptian Plover Black winged Plover	*Charadrius hialicula* *Hoplopterus spinosus* *Pluvianus aegyptius* *Stephanibyx melanopteus*
COLUMBIDAE	Mourning Dove	*Streptopelia decipiens*
(Pigeons, Doves)	Turtle Dove Vinaceous Dove Laughing Dove Namagua Dove Abyssinian Wood Dove Ring necked Dove	*S. turture* *S. vinacece* *S. senegalensis* *Oena capensis* *Turture abyssinica* *Streplopelia capicola*
COLIIDAE	Speckled Mousebird Blue-naped Mousbird	
CORACIIDAE (Rollers)	Abyssinian Roller	*Coracias abyssinicus*
CORVIDAE (Crows, piapiac)	Pied crow	*Corvus albus*
CUCULID	Great spotted cuckoo Senegal coucal	*Clamator glandarius*
DICRURURIDAE	Drongo	*Dicrurus adsimitis*
ESTRILDIDAE (Wax bills)	Wax bills Red-billed fire finch Red-cheeked cordon-blew Cut-throat	*Estrilda astrild* *Lagnosticta senegala* *Uraeginthus bengalus* *Amadina fasciata*

	Silver-bill	*Lonchura malabarica*
FALCONIDAE	Lanner Kestrel	*Falco biarmicus* *Falco tinnunculus*
FRINGILIIDAE (Buting, canaries, seed-Eaters)	Yellow-fronted canary	*Serinus mozambicus*
GLAREOLIDAE	Collared pralincole	*Glareola pratincola*
HIRUNDINIDAE (Swallows)	African sand martin	*Ribaria paludicola*
LARIDAE	Black-headed Gull Gull-billed Tern White-winged Black Tern Grey Headed Gull	*Larus ridibundus* *Gelocheliden nilotica* *Clidonias leucoptera* *Larus Cirocephalus*
LANIIDAE	Nubian shrike Red-black shrike Black-headed Gonolek Wood chat shrike Sulpher-breasted Bush shrike Black-headed Bush Shrike	*Lanius nubicus* *Lanius collurio* *Laniarius erythrogaster* *Lanius senator* *Chlorophoneus Sulfereopectus* *Tchagra senegala*
MEROPIDAE	Carmine Bee-eater Little Bee-eater Red-throated Bee- eater White-throated Bee-eater	*Merops nubicus* *Melittophagus pusillus* *Melittophagus bulocki* *Merops abicollis*
MOTACILLIDAE	White wagtail Blue-headed, yellow Wagtails	*Motacilla alba* *Motacilla flava*

MUSCICAPIPAE (Fly catchers)	Paradise flycatcher Black-headed Batis	*Terpsiphone viridis* *Batis minor*
NECTARINIIDAE (Sun bird)	Beautiful sun bird	*Nectarinia pulchella*
OTIDIDAE (Bustards)	Arabian Bustards Black-headed Bustards Kori Bustards	*Ardeotis arabs* *Lissotis melanogaster* *Ardeotis kori*
PELICANIDAE (Pelicans)	White pelican Pink-black	*Pelecanus onocrotalus* *Pelecanus rufescens*
PICIDAE	Nubian wood pecker Little Brown wood pecker Grey wood pecker	*Campethera nubica* *Dendropicos obsolettus* *Mesopicos gaertae*
PHOENICULIDAE (Wood-hoopoe)	Kakelaar (Green wood hoopoe) Wood Kakelaar	*Phoeniculus purpureus* *Scoptellus aterrimus*
PSITTACIDAE	Nubian wood pecker Little Brown wood pecker Grey wood pecker	*Campethera nubica* *Dendropicos obsoletus* *Mesopicos goetae*
PTEROCIIDIDAE	Painted sand grouse Four-banded grouse	*Eremia lector quadricinctus* *Petrocles quadricinctus*
PRIONOPIDAE	Curly-Crested Helmut shrike	*Prionops Cristata*
PYCNONOTIDAE (Bulbuls)	Common Bulbuls White-vented Bulbuls	*Pycnonotus barbatus*
STURNIDAE	Wattled starting	*Creatophora Cinerea*

(Starlings lox peckers)	Blue-eared Glossy starting Yellow-billed oxpecher Fishers starting Rappell's long-tailed Starting Yellow-billed oxpecher Fishers starting	*Lamprolornis chalybeaus* *Buphagus africanus* *Spreo fisher* *Lamprotornis* *Purpuropterus* *Buphagus africanus* *Spreo fisher*
STRIGIDAE (Owls)	Spotted Eagle owl Verreaux,s, s Eagle owl Pear spotted owlet African Barn owls	*Bubo africanus* *Bubo lacteus* *Galaucidium perlatum* *Marcodipteryx* *Longipennis*
SCOPIDAE (Hammerkops)	Hammerkop	*Scopus umreetta*
STRUTHIONIDAE	Ostrich	*Struthio camelus*
SCOLOPACIDAE (Sand pipers and snipes)	Curlew sand piper Spotted stone curlew European stone curlew Little stint Wood sand piper Greenshank Redshank Common sand piper	*Calidris testacea* *Barhinus capensis* *Burlinus oddinenus* *Calidris minuta* *Tringa Glareola* *Tringa nebularia* *Tringa lotanus* *Tringa hypoleucos*
SYLVIIDAE	Crombec Grey-black cameroptera Red pate cisticola Tawny prinia	*Sylvietta brachyuran* *Cameroptera Brevicaudata* *Cislicola ruficeps*

		Prinia subflava
TURDOIDIDAE	African thrush Common wheat eater Stonechat	*Turdus pelios* *Oenanthe oenanthe* *Saxicola lorguata*
TURDOIDIDAE (Babblers)	White-headed Babbler	*Turdoides leucocephala*

Source: Davis and Winstead 1980, Bateman 1989 and Abdel Hameed, et al (2001).