THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF NATURAL RESOURCES AND TOURISM

NGORONGORO CONSERVATION AREA AUTHORITY

MANAGEMENT ZONE PLAN (2021-2025)

APRIL 2021

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APPROVAL AND GAZETTEMENT OF THE MANAGEMENT ZONE PLAN

This plan has been reviewed and approved for implementation by the Board of Directors of the Ngorongoro Conservation Area Authority (NCAA) on……..…, and gazetted by the Minister for Natural Resources and Tourism on…… through GN……

……

Dr. Damas D. Ndumbaro

MINISTER FOR NATURAL RESOURCES AND TOURISM

LIST OF ABBREVIATIONS AND ACRONYMS

AOPB	Annual Operation Plans and Budgets
CBPP	Contagious Bovine Pleuropneumomia
CCPP	Contagious Caprine Pleuropneumonia
DOA	Department of Antiquities
ECF	East Coast Fever
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
Ereto-NPP	Ereto-Ngorongoro Pastoralists Project
F&MD	Foot and Mouth Disease
GDP	Gross Domestic Product
GIS	Geographic Information System
GMP	General Management Plan
GPS	Global Positioning System
LAC	Limits of Acceptable Change
LAU	Limits of Acceptable Use
LHU	Large Herbivores Unit
MAB	Man and Biosphere Programme
MCF	Malignant Catarrhal Fever
MZP	Management Zone Plan
NBS	National Bureau of Statistics
NCA	Ngorongoro Conservation Area
NCAA	Ngorongoro Conservation Area Authority
NEMC	National Environmental Management Council
NHFR	Northern Highland Forest Reserve
NP	National Parks
PAs	Protected Areas
RDP	Rural Development Policy
SENAPA	Serengeti National Park
SME	Serengeti-Mara Ecosystem
TANAPA	Tanzania National Parks
TAWIRI	Tanzania Wildlife Research Institute
TLUs	Tropical Livestock Units
UNESCO	United Nations for Science, Education and Culture Organisation
URT	United Republic of Tanzania

PREFACE

Ngorongoro Conservation Area (NCA) was established as a wildlife protected area in 1959, by Ordinance No. 413, as amended by the Game Parks Law of Tanzania (Miscellaneous Amendments) Act No. 14 of 1975, which also established the Ngorongoro Conservation Area Authority (NCAA) to manage the NCA. Overall management of protected areas is guided by the Wildlife Conservation Act No. 5 of 2009, which requires each area to have a General Management Plan (GMP). Since its establishment, the NCAA has developed several General Management Plans of which the most recent expired in 2016 and necessitated its review.

However, as the ongoing review of the multiple land use model of the NCA hindered development of the GMP, the Management Zone Plan (MZP) was developed as an interim plan to guide the management and development of the NCA's resources. The MZP is a five-year plan (2021–2025) developed challenges affecting the sustainability of the NCA. It consists of six chapters detailing the background of the NCA and NCAA, situation analysis of the area, management zone planning and implementation framework.

The main challenge that affects every facet of the NCA is the changing relationship between the major factors and variables of the biotic and abiotic resources. These factors include the growing human population and human uses, change in the culture of the NCA, the growth of wildlife, reduced vegetation cover, changing rainfall patterns in and around the NCA, the increased number of invasive species and the changing distribution and movement of wildlife. Therefore, to achieve the desired conditions, three management zones, namely, core conservation zone, recovery zone and Loliondo conservation zone, have been identif management interventions to be undertaken in each zone. Further, this MZP outlines management objectives, strategies and interventions to be implemented during a period of five years.

Subsequent planning and annual implementation will be guided by the direction established by this plan, whose components may be reviewed periodically when necessary, to reflect new issues or changes in The NCAA staff and stakeholders within and outside the NCA are urged to support the initiatives layed out in this plan, and demonstrate their willingness to protect, conserve and promote NCA resource values.

STATEMENT FROM THE CONSERVATION COMMISSIONER

The Management Zone Plan sets out the basic management and development philosophy of NCA land including the zoning scheme. An MZP document also includes key information about the NCA/NCAA for use by the management and stakeholders, such as trends of the key variables of the NCA, analysis of key issues or concerns, NCA significance and purpose, exceptional reso envisaged and desired future of the NCA, strategic actions and appraisal of the MZP.

The MZP serves other significant purposes, suc to-day operations management as well as long-term management. It helps managers to look at options for achieving their objectives, evaluating the advantages and disadvantages of different courses of action steps. In this way, the mistakes of the past can be avoided, and successful practices applied to comparable situations. MZP can also be used as a public relations document to help direct and raise funding for projects in NCA management and provides a framework for the rational use of limited NCAA resources.

Development and implementation of the MZP involves a huge amount of time and resources. Nonetheless, without the MZP, it to achieve a balance between use and preservation in the NCA. If there is no MZP, preservation activities, development and use will occur in a haphazard fashion, often in response to political and economic pressures with little consideration of implications for the future. The results are likely to be lost opportunities and irreversible damage to the NCA's resources and values.

Dr. Freddy Safeli Manongi
CONSERVATION COMMISSIONER

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ACKNOWLEDGEMENT

The Ngorongoro Conservation Area Authority (NCAA) wishes to acknowledge the work of the National Land Use Planning Commission (NLUPC) in coordinating preparation of the Management Zone Plan of Ngorongoro Cor sincere gratitude is extended to all stakeholders for their participation and valuable inputs in the development of this plan.

The stakeholders involved in the review process include Arusha Regional Secretariat, the NCAA Management Team, Ngorongoro Pastoral Council, the NCAA Workers Council, Traditional leaders (Laigwanan), NCA indegenous residents, the District Management Teams of Monduli, Longido, Meatu, Karatu and Ngorongoro Districts, leaders and representatives of councils in all villages adjacent to the NCA, Members of the Hotels Association of Tanzania, Members of Safari Guides Association of Tanzania and Tour Operators of Tanzania. Other stakeholders involved are Oxfam Tanzania, Tanzania Natural Resources Forum (TNRF), CORDS, LANDESA, Ujamaa Community Resource Team, SOLIDARIDAD, Pastoral Women Council of Arusha (PWC) and African Wildlife Foundation.

CHAPTER ONE: BACKGROUND INFORMATION

1.1. History of the Ngorongoro Conservation Area

1.1.1. Establishment of the NCA and NCAA

Ngorongoro Conservation Area (NCA) in Tanzania was established in 1959 by Ordinance No. 413, as amended by the Game Parks Law of Tanzania (Miscellaneous Amendments) Act No. 14 of 1975, which also established the Ngorongoro Conservation Area Authority (NCAA) to manage the NCA. Before the establishment of the NCAA, the management authority of the NCA was vested in the Wildlife Department of the Ministry responsible for natural resources and tourism. The NCA Ordinance was later revised by the NCA Act CAP 284 of 2002. However, in 2018, the NCAA was granted man sites found outside the NCA: the Mumba Rock in Karatu district, Engaresero Footprints in Ngorongoro district, Engaruka Ruins in Monduli district, Kimondo Meteorite in Mbozi district and Amboni Caves in Tanga. Also, in 2020, Loliondo Game Controlled Area, Salei Plains and Selela Village Forest Reserve were annexed to the Ngorongoro Conservation Area. Therefore, the current NCA boundary encompasses the annexed areas as shown in Map 3.

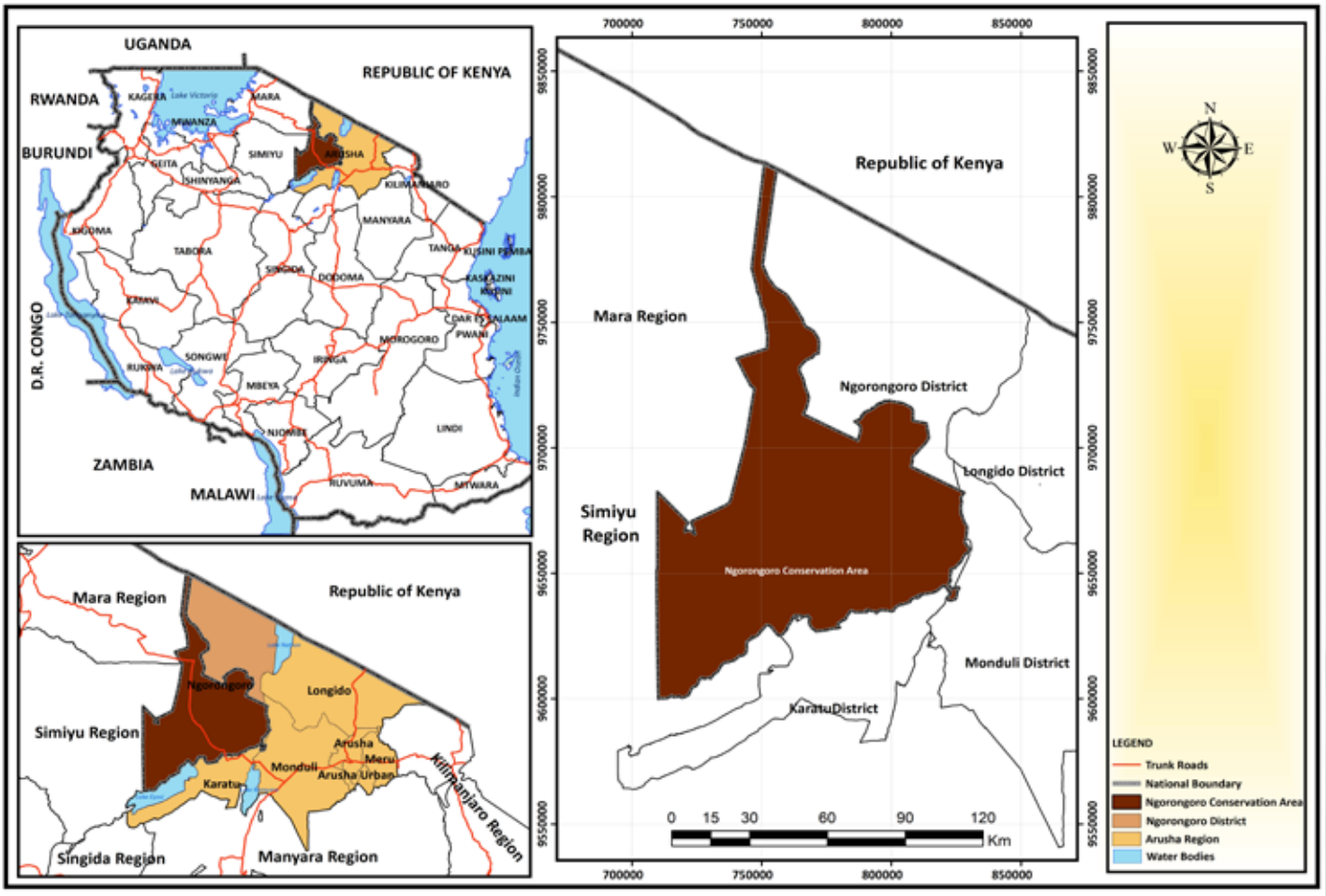
Due to its outstanding universal values, the NCA was added to the World Heritage List in 1979 after meeting criteria prescribed by the World Heritage Convention. Additionally, the NCA has been recognised as part of the Serengeti-Ngorongoro Biosphere Reserve, under UNESCO's Man and the Biosphere Programme (MAB) since 1981. In 2010, the UNESCO World Heritage Committee reinscribed the NCA as a mixed property on the World Heritage List. The committee based its decision on the extraordinary record of human evolution at the site, which spans a vast area of land from the Serengeti National Park in the northwest of Tanzania to the eastern arm of the Great Rift Valley. The NCA was voted as one of the Seven Natural Wonders of Africa in 2013.

1.1.2. Location and Area of the NCA

The NCA is located in Ngorongoro district 03 °14'.715 S and Longitude 35 °29'.275 E. During its establishment, the NCA had an area of 8,292 square kilometers. However, following a review of the boundary in 2017, the area was shown to be 8,140.42 s of Loliondo GCA and Engaruka ruins and Selela Village Forest Reserve, the new NCA boundary covers an area of 9,692 square kilometers. The NCA borders Lake Eyasi, the agricultural communites of Oldeani (Oltyar

forests in the south and southeast in Kara
Lengai mountain, Lake Natron GCA and Sale Plains in the north-east. The NCA borders
Tanzania and Kenya boundary and Serenget N
To the west, the NCA is bordered by Maswa
Engaruka Plains in Monduli district (Map 1

Map 1: Natonal setng of the Ngorongo



1.1.3. Outstanding Resources and Values of the NCA

The outstanding resources and values of the NCA capture the essence of its creation and existence as a conservation area, and help maintain its status as a World Heritage Site and an International Biosphere Reserve. Such resource values must be protected and preserved to NCA. Outstanding resources are not limited to those within NCA boundaries (Map 2). In principle, they include:

a) Outstanding examples of the natural, scen foral, faunal and recreational values fo

b) Areas essential for protecting the ecological integrity of the NCA.

c) Areas critical for maintaining water flow integrity of the NCA.

d) Rare and endemic plants and animals.

e) Sensitive, threatened, or endangered plants and animals.

f) Resources unusually sensitive to human use.

g) Major archeological or historical sites.

h) Major local cultural sites.

i) Resources with international recognition.

The identifcation of outstanding values al decision makers to focus their efforts and staff on the most important resources.

The Management Zone Plan identifed the fo (Map 2) and values of the NCA:

a) Ngorongoro, Empakai and Olmoti craters.

b) Nasera rock, Gol Mountains, Lemuta Hills and Ilkarian Gorge.

c) Oldeani and Makarot mountains.

d) Lake Eyasi and its escarpment and basin.

e) Serengeti, Ang'atakiti and Sale Plains.

f) Oldupai Gorge and Alaitole footprints.

g) Ndutu and Masek lakes.

h) Shifting sands.

i) Olbalbal wetlands and Malanja depression.

j) Ndutu Plains.

k) Wilderbeest migration.

l) Northen Highland Forest Reserve.

m) River Munge.

n) Acacia Lahai and Elerai forests.

o) Oldoinyo Loolsirwa and Loolmalasin montane heath or moorlands.

p) Visible populations of rhinos and elephants.

q) High density of wildlife.

r) Wildlife corridors.

s) Endoro elephant caves.

t) UNESCO designations (Geopark, Biosphere Reserve, World Heritage Site).

1.2. SNiQgAnifcance

In addition to the major signifcance and v
including the scenery and diverse and highest wildlife density in the Ngorongoro Crater, the Serengeti Plains and its migratory wildlife species, the Northern High Forest Reserve and the palaeontological and archaeological sites found in the NCA, other values are the following:

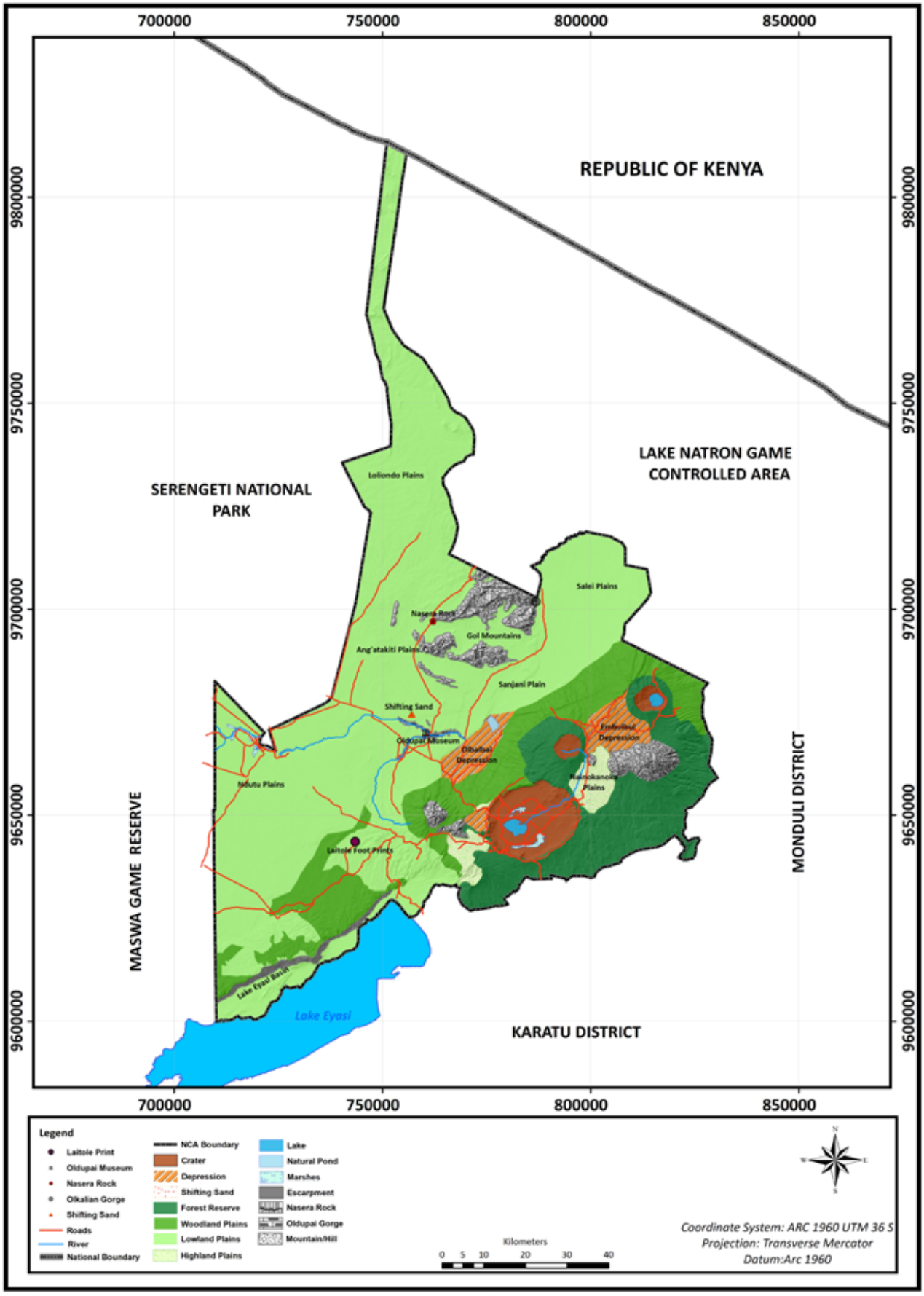
a) The NCA is one of the most visited tourist destinations in Tanzania and as such, it is an important economic resource for local residents, the region and the nation;
b) The NCA multiple land use system is one of the earliest to be established around the world as a means of reconciling human development and natural resources conservation; and
c) The NCA has been designated by UNESCO as a World Heritage Site and International Biosphere Reserve.

1.3 Existing Purpose of the NCA

The existing purposes of the NCA are based on the objectives of its establishment in 1959, which are further defned in the
The multiple land use area seeks to ensure sustainable natural resources management and tourism development, and to safeguard and promote community development. The following purpo

a) To maintain dynamic multiple and sustainable land use systems, which perpetuates the historic balance of people and nature;
b) To conserve the biodiversity and ecological integrity of the Serengeti ecosystem and Ngorongoro highlands;
c) To conserve the area's internationally archaeological sites and resources;
d) To safeguard and promote the rights of NCA indigenous residents through controlling their economic and cultural development in a manner that leaves exceptional resources unimpaired;
e) To encourage responsible tourism, which national and international economy;
f) To provide opportunities for interpretation, education and research concerning the area's natural and cultural resources; and
g) To maintain and promote those values for which the area is designated as a World Heritage Site, Global Geo- Park and International Man and Biosphere Reserve.

Map 2: Resources of the NCA



1.4 Management of Ngorongoro Conservation Area (NCA)

1.4.1. Management Zone Plan (MZP)

A Management Zone Plan is a tool that sets out basic management and development philosophy for a protected area and provides strategies for addressing challenges and achieving ident
basis for development of management plans for protected areas is provided under Section 34 of the Wildlife Conservation Act No. 5 of 2009.

1.4.2. Rationale of the Management Zone Plan

The NCA requires the General Management Plan to be a comprehensive tool for guiding management of the area. It forms the basis for protecting the outstanding resource values of the NC
Since its establishment, the management and development of the NCA has been guided by the General Management Plans (GMPs) prepared in different periods, most recently in 2006, and which expired in 2016. Nevertheless, the NCA continues to experience management challenges arising from expansion of human settlements, increasing human and livestock population and climatic change. These challenges necessitate the review of existing plans to cope with conservation and other national development needs.

However, due to the ongoing review of the multiple land use model, key decisions need to be made. These are procedural and take time, while some existing management challenges are threatening the sustainability of the area, which means it is not possible to await completion of the review process and availability of the GMP. Thus, the MZP has been developed as an interim plan to address pressing management challenges in the NCA.

1.4.3. Legal Basis for Developing the MZP

The basis for developing the MZP in Tanzania is guided by the following legal frameworks:

Wildlife Conservation Act of 2009

Section 34 (1) of the Wildlife Conservation Act provides for preparation of management plans for protected areas. Development of the MZP for the NCA will guide protection, conservation and development for sustainable utilisation of NCA resources.

Ngorongoro Conservation Act of 2002

Section 27 of the Ngorongoro Conservation Area Act of 2002 provides for measures to be taken by the Authority within the Conservation Area for (a) the control, conservation and utilisation of water including storm water, (b) the protection of the source, course and banks of streams, rivers, furrows, waterholes, watercourses, wells and lakes, (c) the mitigation and prevention of soil erosion, (d) the protection of fora a extinguishment of grass fres and (f) the i water resources. This MZP has been prepared based on the above requirements and encompasses measures to address the existing challenges of the NCA.

Environmental Management Act of 2004

Section 49 (2) of the Environmental Management Act provides for each protected area to prepare and implement a managemen biologal diversity, describes the boundary of the national protected area, and defnes management measures to be taken wi zoning, use and access restrictions) and the means to monitor implementation of the plan.

1.5. Approach Adopted for Developing the MZP

Development of the MZP for the NCA involved preparation, data collection, data analysis and presentation and development of management zones.

1.5.1. Preparation

This stage involved preparation of tools for data collection such as a checklist for key informant interviews, focused group dicscussions and spatial data collection. Previous NCAA plans, satelite images and a survey plan of the NCA boundary were acquired and used to prepare the NCA base map. Also, a literature review of various documents from different institutions was undertaken to collect secondary information and data related to wildlife, climate and land use land cover of the NCA. Previous and existing NCA related plans and reports, policy and legislation governing natural resources management in protected areas were reviewed and key information and data documented.

1.5.2. Data Collection

Spatial and non-spatial data were collected. Spatial data were collected using hand-held GPS, and the coordinates for location and boundaries of features and land uses were documented. These data were used to produce different maps

including the NCA resources map. Moreover, during spatial data collection to identify different management issues of the area including but not limited to soil erosion, invasive species, pollution, status of rangelands and extraction of forest resources.

Non-spatial data were collected through focused group discussion and key informant interviews. Three focused group discussions and four key informants interviews involving residents, local government leaders of neighbouring villages and districts, Civil Society Organisations, Tour Operators, members of the Hotel Association and Safari Guides Association, NCAA workers councils, NCAA management and Board of Directors were conducted to provide information on management challenges and the desired future conditions of the NCA.

1.5.3 Data Analysis and Presentation

The spatial data collected were analysed using computer-based GIS software and presented in the form of maps depicting trends of land uses, existing socio-economic inftrastructures and services and the physical conditions of the area. Non-spatial data collected were analysed using statistical tools, for example,Ms Excel, STATA and SPSS. Analysed data such as existing facilities, human and livestock population, distribution of social services and wildlife numbers were presented including in the form of tables. Findings from the analysis helped to shed light on existing NCA conditions, challenges and formulating management objectives to achieve desired future conditions.

1.5.4 Development of Management Zones

Based on management objectives, criteria for designating NCA management zones were established. These criteria focused on ensuring that the outstanding core resources and values of the NCA are preserved and protected. Thus, three management zones were designated, namely, core conservation, recovery zone and Loliondo conservation. These zones were shared widely with key stakeholders through meetings and presentations. The views and suggestions provided were included in the fnal plan.

CHAPTER TWO: TRENDS ANALYSIS

2.1 Regulatory Frameworks

2.1.1 Legislative Trends

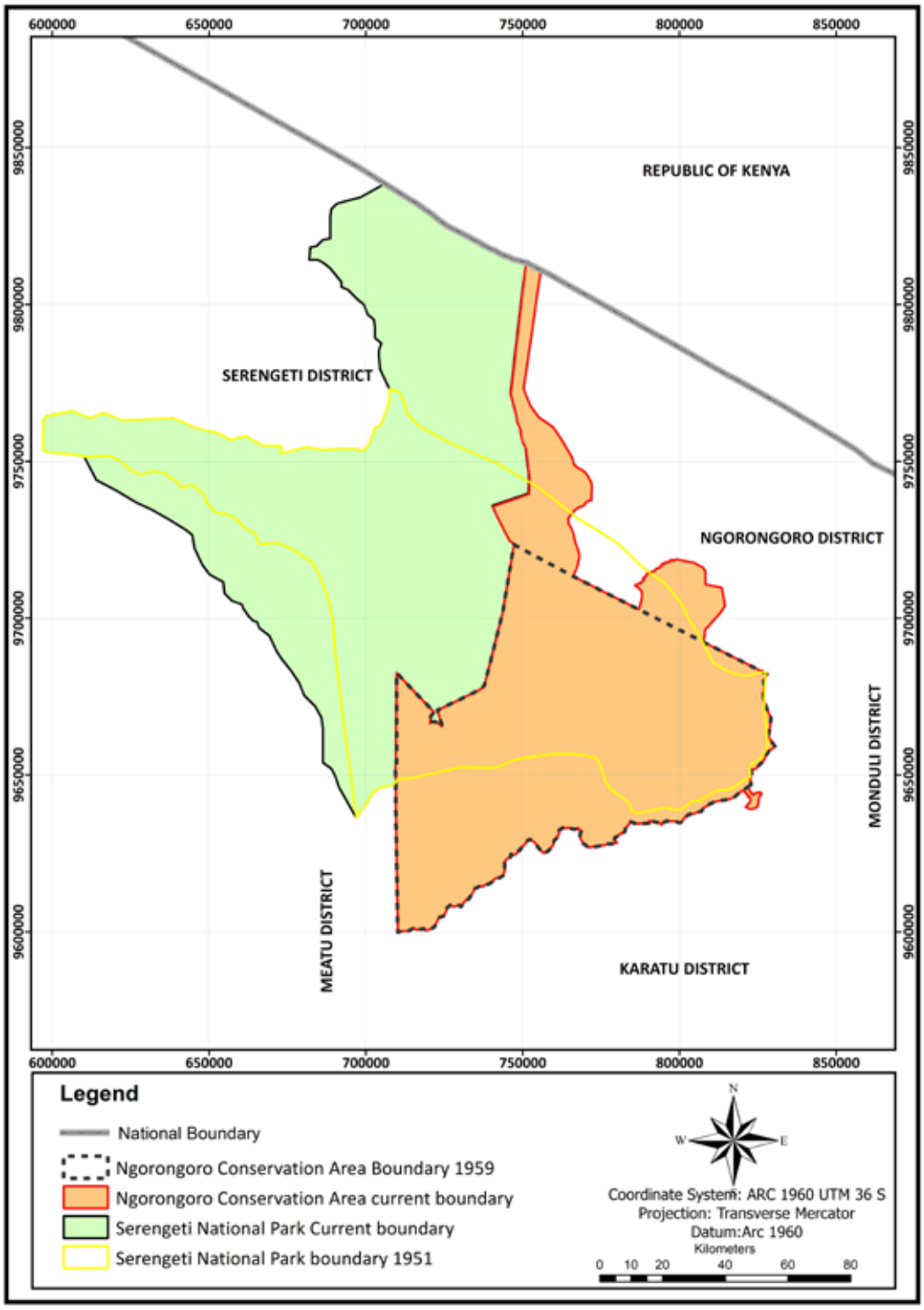
The Game Ordinance of 1940 governed wildlife conservation during colonial Tanganyika, and was replaced by the Fauna Conservation Ordinance No.17 of 1951, which provided for the creation of three categories of Protected Areas in Tanganyika: Game Reserves, Game Controlled Areas and Partial Game Reserves. Ngorongoro Conservation Area was by then part of the Serengeti Game Reserve. Negotiations to separate the NCA from the Serengeti Game Reserve began in the early 1950s. As a result of these negotiations and consultations with both the Maasai and the colonial government machinery, the Tanganyika government in Seasonal Paper No of the Serengeti Game Reserve (Map 3). Th Maasai from the western and eastern Serengeti Game Reserve and excise the Ngorongoro Highlands from the current Serengeti National Park was reached in 1956. The government decided to establish an independent, multiple land use unit under the Ministry of Lands, Forests and Wildlife (now the Ministry of Natural Resources and Tourism) in the same year. NCA resident pastoralists were assured that their interests would be protected in the new multiple land use area, and different compensation schemes were promised, particularly water development for range improvement. On the basis of these proposals, the Maasai living in Serengeti Game Reserve (now Serengeti National Park) agreed to move to the now NCA.

The National Parks Ordinance CAP 253 of 1956 was enacted and changed the legislative status of the NCA. Also, the same Ordinance created a category known as National Parks, which removed National Parks from the control of the Game Department to an independent Board of Trustees called the Tanzania National Parks. This legislation was later updated as the National Parks Ordinance CAP 412 of 1959, which prohibited settlement in National Parks. The NCA was then excised from the original Serengeti National Park in 1959, and then established under Ngorongoro Conservation Area Ordinance, CAP 413 of 1959.

The Wildlife Conservation Act No. 12 of 1974 repealed the Fauna Conservation Ordinance No.17 of 1951. This Act accommodated both the TANAPA and NCA Ordinances. Due to administrative challenges that led to the poor performance of the Ngorongoro Conservation Unit, a more active body was later proposed to administer the area. The Game Parks Laws No.14 of 1975 elevated the status

of the NCA administrative body to an autonomous Parastatal Organisation. The primary responsibility for the administration and management of the area, therefore, was vested in the NCAA. Following the establishment of the NCA, the administration of the Northern Highland Forest Reserve was also transferred to Ngorongoro Conservation Unit. Amendments to the Ngorongoro Conservation Area Ordinance in 1975 did not change the philosophy of the NCA, but created a parastatal organisation to manage the area known as Ngorongoro Conservation Area Authority (NCAA).

Map 3: Trends of NCA boundaries



2.1.2. Management Plans Development Trends

Since its establishment, different management plans have been developed to guide management and development of the NCA. Earlier plans placed emphasis on specifc elements of conservati aspects of natural resources management, tourism development and improving the livelihoods of NCA residents. Further details and descriptions of these management plans are presented in the following sub-sections.

Ngorongoro Conservation Area Authority Management Plan 1960

At the time of writing this plan, the Conservation Area was in its infancy, and there was considerable confusion and uncertainty over the structure and objectives of the Authority. As a result, the plan suffered from a lack of prescriptions; there were few guidelines on how different parts of the NCA were to be managed, and a lack of clear policy on multiple land use. A more serious shortcoming was the plan's paternalistic attitude to the NCA indigenous residents, and its emphasis on the use of compulsion to achieve management goals. It is evident that NCA indigenous residents did not contribute to the plan, nor were any mechanisms envisioned for incorporating them in the management of the Area. A notable strength of the plan was its emphasis on viewing the NCA as one component of a larger ecosystem; the need for liaison and cooperation between the NCA and Serengeti National Park, particularly in light of the movements of migratory herds of wildebeest, zebra and gazelle across the wider Serengeti ecosystem (URT, 1997).

Ngorongoro Conservation Area Authority, Revised Management Plan 1962

The 1962 plan suffered from essentially the same weaknesses as the 1960 version. However, the plan included policy guidelines for the management of the NCA as a whole, as well as at the sectoral level (for example, for water development), which emphasised the need for a stable environment where the NCA's human and animal inhabitants could prosper, and stressed the importance of meeting the diverse requirements of the Area in full. Although these policy initiatives were a signifcan savannah ecosystems such as Ngorongoro are typically cyclical in nature, making it unrealistic to aim for a uniformly stable environment. Similarly, it is unrealistic to attempt to meet all management objectives fully in all areas (URT, 1997).

Management Plan of 1966

The plan drew attention to the need for three levels of policy and objectives: government-level directive laying out the overall goals and purpose of the Area (Dirschl uncritically accepts the 1962 plan policy statement in this regard), a set of Area-wide objectives and management zones in the Area. The plan noted the lack of any routine meetings with NCA indigenous residents, and called for the establishment of a permanent forum to this end. A comprehensive land-use zoning scheme was proposed, in which areas would be used for cultivation, wildlife conservation, forest protection and relatively intensive pastoral development. However, the land-use zoning system proposed the establishment of 17 different land-use zones, each with its own objectives and land-use plan, which were too complex to be implemented. Although a number of individual recommendations were eventually put into effect, the plan as a whole was overtaken by the controversy surrounding the Ministry of Agriculture's proposal to reduce the size of the Area, and was never adopted as government policy (URT, 1997).

Management Plan of 1982

This plan recommended implementing a zoning scheme, and promoting pastoral development more actively. To further this goal, the plan recommended a number of steps including the surveying of village boundaries and strengthening of village governments, the creation of an elected council of village leaders, greater integration of the district in livestock and water development and the establishment of a new NCAA department concerned with rural development. However, this also failed to be accepted as government policy (URT, 1997).

General Management Plan of 2006

The General Management Plan of 2006 was p
challenges, issues and/or concerns facing
issues and objectives were categorised in
namely. natural resources, cultural resources, community development, tourism and administration and operations. Also, t
resources that capture the essence of why the NCA was established as a conservation area. They include Ngorongoro Crater, Empakaai Crater, Oldonyo Lengai, Gol Mountains and Ilkarian Gorge, Olmoti, Oldeani and Makarot geological features, Lake Eyasi and its escarpment and basin, Lake Natron and its escarpment and basin, Serengeti, Ang'ata Kiti and Sale Plains, Oldupai Gorge, Alaitole footprints at Ngarusi and Lake Ndutu/Masek Basin, shifting sands, Olbalbal wetlands, *A. Lahai* and Elerai forests, Oldoinyo Loolsirwa

and Loolmalasin montane heath/moorlands, visible populations of rhinos and elephants, high density of wildlife, wildlife corridors, Maasai pastoralists, Tatoga agro-pastoralists and Hadzabe hunter-gatherers cultures and cultural areas and resources. These outstanding values help maintain the NCA's status as a World Heritage Site and an International Biosphere Reserve.

The GMP of 2006 delineated four management zones and two sub-zones based on the management challenges, objectives and outstanding resource values of the NCA. In addition, land use capability and suitability to support different types and levels of use were important factors that were considered in developing the management zone scheme for the NCA. The four management zones and two sub-zones were as follows:

a) Crater zone including Ngorongoro, Olmoti and Empakaai craters;
b) Catchment forest zone including the Northern Highlands Forest Reserve and the bamboo "Oldean" forest;
c) Development zone encompassing the central and northern part of the NCA, the highland grasslands and the Rift Val
d) The external resource zone formed of the main areas situated outside the NCA, but which can be visited and add to visitor attractions as a whole. These are in the southern area and include Lake Eyasi and the Yaeda Valley, and the northern area, where Lake Natron and Oldoinyo Lengai, the only Tanzanian active volcanoes, are situated;
e) The Oldupai Gorge sub-zone, which encompasses a 5-kilometre stretch on either side of Oldupai and Kiloki rivers; and
f) The short grass plains sub zone, which is the carving ground for the Serengeti ecosystem migrating wildebeest.

2.2. Ecological and Climatic Trends

2.2.1. Climate Trends

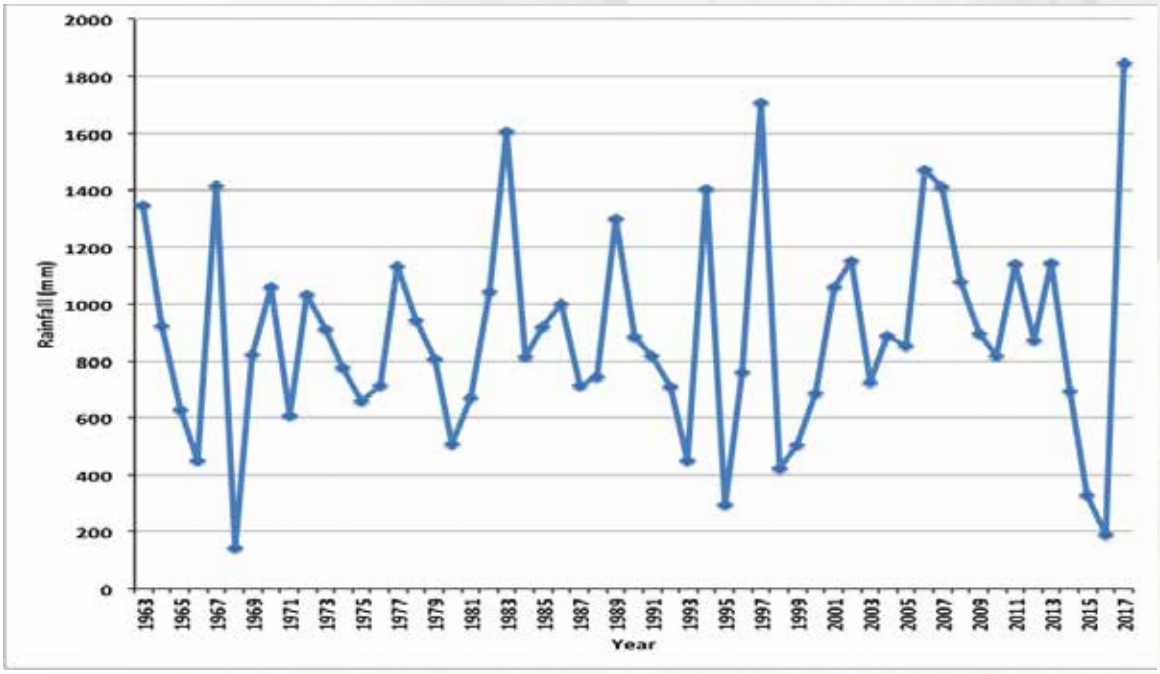
2.2.1.1. Rainfall Patterns

The most important aspect of climate in this region, as in all other largely semi-arid areas, is rainfall, which governs vegetation production and the availability of water. The quantity and quality of plant food and water are major factors in both wild and domestic stock's ability to use the area. In the NCA, rainfall is highly variable within and between seasons and years, and is determined by large-scale tropical weather patterns, local topography is so pronounced, there are great variations of rainfall patterns

within the NCA. The rainfall is associated with the inter-tropical convergence zone (ITCZ) of the trade winds of the northern and southern hemispheres. This causes areas close to the equator to have two distinct peaks in the rainy season.

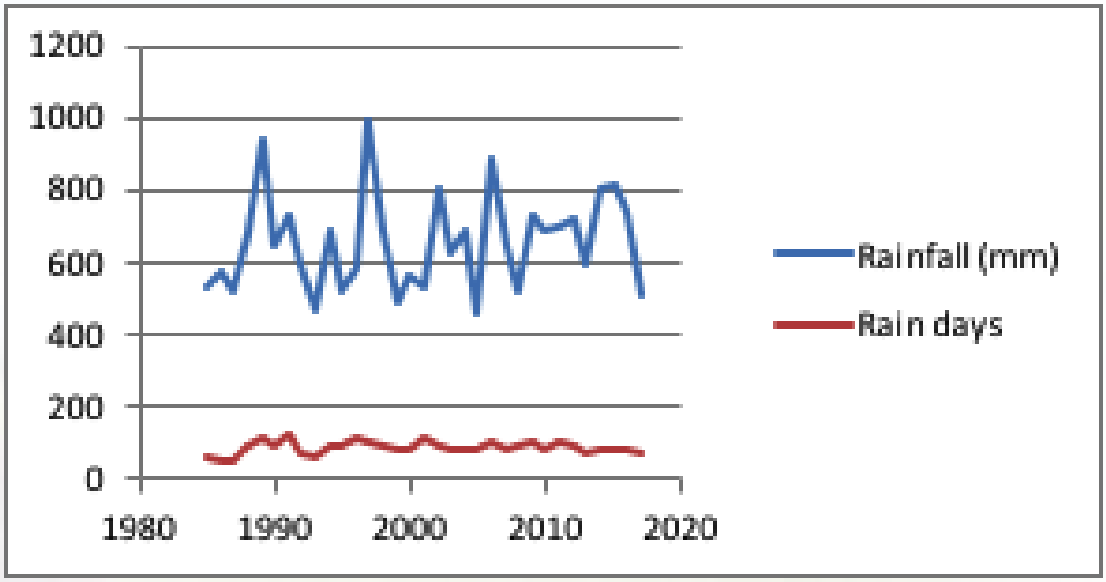
Generally, the NCA is going through a series of drought with almost complete failure of the short-rains (NCAA, 2006). Simulation of the inter-annual rainfall data between 2006 and 2010 from the NCAA headquarters' rain station revealed that rainfall in the NCA will continue to depict a sustained quasi-cyclic oscillation pattern (Ogutu *et al.,* 2019). The plains are poorly supplied with springs and permanent water sources because the peaks of the Crater Highlands intercept the easterly moisture laden winds and force them to drop most of the rain on the eastern side compared with the north-western part of the region, which lies in a rain-shadow area (Aikman and Cobb, 1997). For instance, between 1963 and 2017, the only long-term station (on the Ngorongoro Crater rim at the NCAA headquarters) showed an annual average of 870.5mm. The spatial rainfall variability is depicted by annual rainfall data from the NCAA headquarters and Ndutu rain stations (Figures 1 and 2). The latter station received an annual average of less than 500mm between1985 and 2017.

Figure 1: Rainfall trends between 1963 a



Source: NCAA, 2017

Figure 2: Rainfall trends and rain days b



Source: NCAA, 2017

2.2.1.2 Temperature

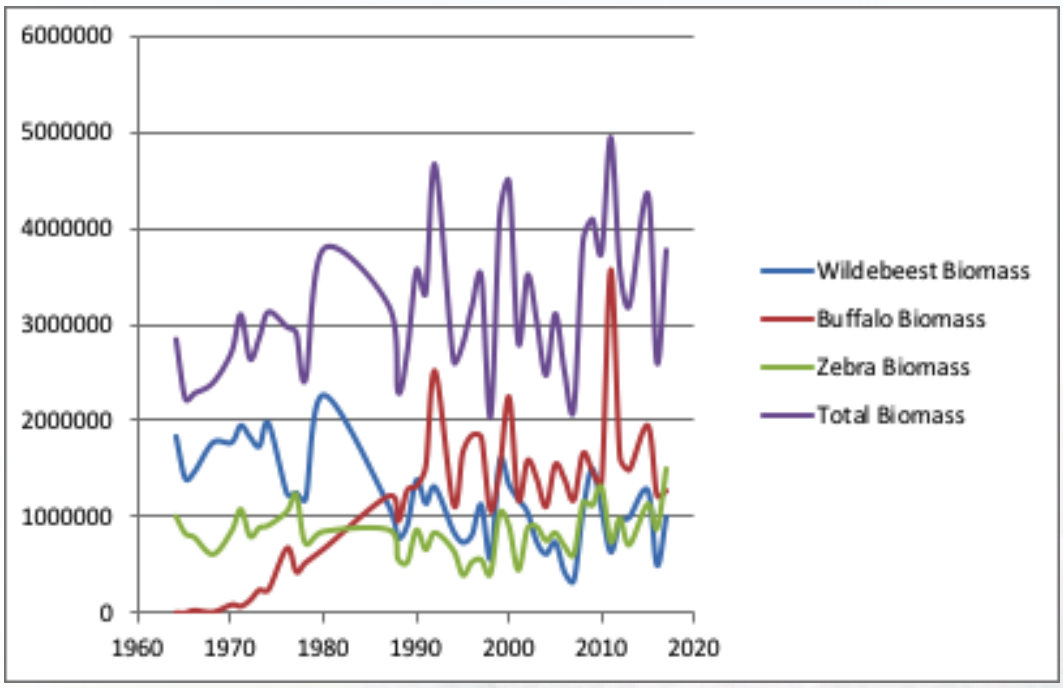
On average, temperatures decrease by 1°C for every 200 metres increase in altitude. The NCA has a vertical difference of 2500 metres and this, coupled with the diverse topography, gives rise to a range of micro-climates. Temperature records throughout the area are poor, but the lower lying plains can be described as arid and hot with shade temperatures at Oldupai reaching 38°C (Homewood and Rodgers, 1991). The climate of the NCA and the whole of Serengeti ecosystem is tropical. It is usually warm and dry, with mean monthly maximum temperature of 27–28°C all year ro temperature of 13–16°C (Sinclair and Arces

2.2.2. Ecological Trends

2.2.2.1. Wildlife Population Trends

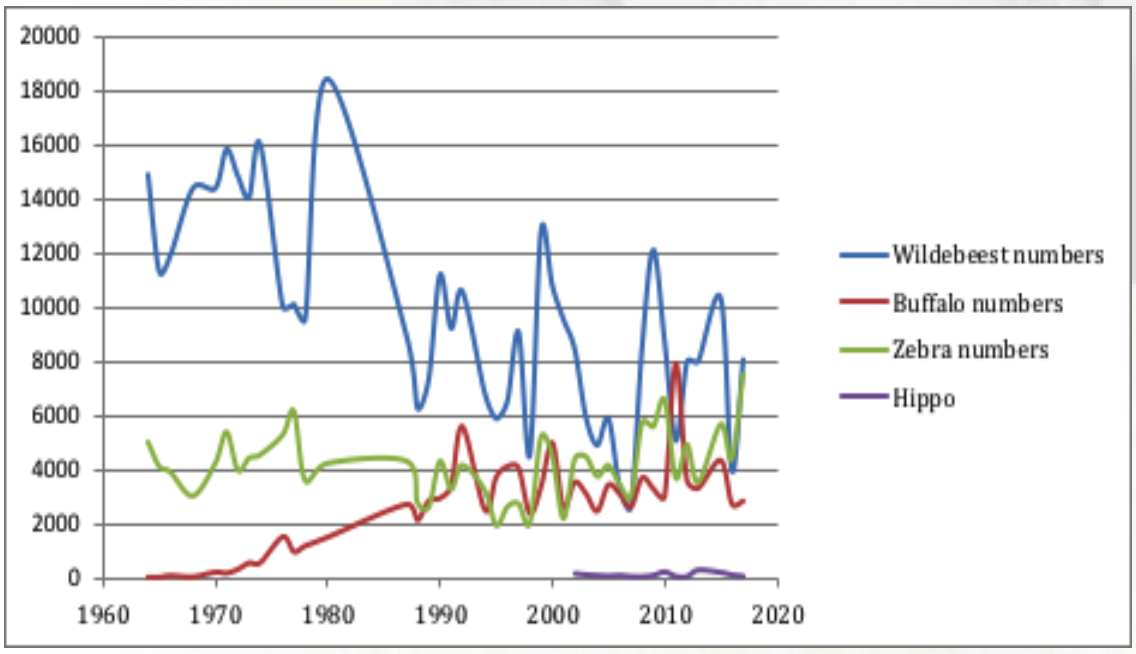
Data collected in Ngorongoro Crater for the period of 53 years from 1964 to 2017, show a general decrease in wildebeest and plain zebra populations, and their replacement by buffalo as the dominant herbivore in terms of biomass. The wildebeest indicate a decreasing trend from an average of 8,179 to 5,526, while zebra decreased from 2,900 to 2,655, and buffalo are increasing in number and corresponding biomass (Figures 3 and 4). The decrease in wildebeest population size was quite high (32%) compared with that of zebra, which was about 8%. Buffalo and warthog (*Phacochoerus aethiopicus*) are relatively recent colonisers of the crater grassland. Wild dogs were present in the 1960s, but are now observed rarely. Small numbers of lions and cheetah appear to be intermittent visitors.

Figure 3: Main species biomass and tota



Source: NCAA, 2017

Figure 4: Populaton changes in four



Source: NCAA, 2017

2.2.2.2 Drivers of Changing Wildlife Population in the NCA

Primary drivers of change in herbivore populations are vegetation change and diseases, which are directly linked to precipitation. Long-term data analysis on rainfall from the meteorological station at the NCAA headquarters for the period

between 1963 and 2012 revealed that the projected ungulate population dynamics in the Ngorongoro Crater emulate upheld oscillations in the predictable rainfall patterns (Ogutu *et al.,* 2019). This means that rainfal herbivore abundance in the NCA. The oscillations are associated with recurrent severe droughts that cause food scarcity and hence nutritional stress for large herbivores. High rainfall supports above-average production of plant biomass, which may be of low quality due to the dilution of plant nutrients. Large-sized herbivores dependent on bulk, low-quality forage should prosper under the wet and cooler conditions, whereas small-sized herbivores requiring high-quality forage should thrive under relatively low rainfall and warmer conditions (Ogutu *et al.,* 2019).

Poaching and diseases are other factors that have contributed to the changing wildlife population in the NCA. The signif in the NCA from the early 1970s to the 1980s was mainly attributed to poaching. Before the 1960s, black rhinos in Serengeti plains were about 700, in Oldupai there were 60, and in Ngorongoro Crater there were more than 100 (Mascarenhas, 1993; Fyumagwa and Nyahongo, 2010). By the 1980s, poaching for trophy decimated the rhino population to two and 12 individuals in Serengeti and Ngorongoro Crater respectively.

With regard to diseases, from the 1880s to 1980s, rinderpest (a Morbillivirus similar to canine distemper virus) was a major cause of mortality for buffalo, wildebeest and eland in the Serengeti ecosystem including the Crater Highlands. There was serious outbreak affecting yearling buffalo adjacent to the Ngorongoro Crater in 1961 (Machange, 1997). Inoculation campaigns of cattle against rinderpest supported the buffalo population to more than double and the wildebeest population to more than triple in the Serengeti-Mara Ecosystem (SME) from the numbers that were recorded in the 1960s. Fortunately, rinderpest virus was eradicated, and Tanzania declared free from the virus in 2005. However, over time, other wildlife diseases have been emerging. For example, *Babesiosis* caused by *Babesia bicornis* parasite, which killed f in Ngorongoro Crater in January 2001, was an emerging disease in the NCA (Morkel, 2001; Nijhof *et al.,* 2003), and there were frequent outbreaks of anthrax in other herbivore species.

2.2.2.3. Stocking Rate and Limits of Acceptable Use

In 1994, total LHUs in the NCA were estimated to be 488,886 in wet season and 122,110 during dry season. Of this total, domestic herbivore accounted for 20% (97,033) during wet season and 80% (97,033) during dry season (Boone et al.,

2002). According to the 2017 livestock and wildlife counts in the Ngorongoro Crater, LHUs were estimated to be 602,544 in wet season and 235,477 during dry period, when livestock accounted for 35% and 90% respectively. This indicates that livestock populations in the NCA were increasingly displacing wild herbivores. Further, whereas cattle accounted for 86% of the total domestic LHUs in 1994, this number declined to 80% in 2017 (Table 1). The above analysis shows that while the rate of livestock populations increase in the NCA was relatively higher than that of wildlife, small stock, particularly sheep, was increasingly replacing cattle, which was probably a strategy to cope with deteriorating rangelands, increased water scarcity, disease epidemics and effects of climate change.

The fact that the total LHUs for both wildlife and livestock during wet season in 1994 (488, 886) and 2017 (602,544) was above the estimated limit of LHUs (250,925) stocking rate of the NCA in 1994 (Boone et al., 2002), and that of the 2017 dry season (235,477) was approaching threshold, this was indication that NCA capacity to support any additional herbivores both wild and domestic was no longer feasible. However, this conclusion does not take into consideration some negative aspects, which may have lowered further the area's carrying capacity that was estimated to be 250,925 LHUs in 1994 (Boone et al., 2002). These aspects are persistent deterioration of the rangelands, increasing water scarcity, prolonged drought, relatively fewer rain-days some years and prevention of co-utilisation of the plains by wildebeest and cattle between February and April due to avoidance of the latter from contracting *Malignant Catarrh Fever* (MCF) disease, which is transmitted by the former.

Table 1: Populaton estmates for large her

Functonal Group	Body Mass (Kg/Animal)	1994 (Source: Boone et al. 2002)			2017		
		Number	***LHUs (WS)***	***LHUs (DS)***	***Number***	***LHUs (WS)***	***LHUs (DS)***
Cattle	180	115,468	83,137	83,137	238,826*	171,955	171,955
Goats and Sheep	18	193,000	13,896	13,986	570, 633*	41,086	41,086
Migratory Wildebeest	123	625,000	307,500	0	625,000****	307,500	0
Migratory Zebra	260	62,959	50,567	0	62,959****	50,567	0
Migratory Grazing Antelopes	150	150,000	9,000	0	150,000****	9,000	0
Resident Wildebeest	123	9,000	4,428	4,428	9,575**	4,710	4,710

Resident Zebra	200	7,087	5,670	5,670	4,027**	3,258	3,258
Resident Grazing Antelopes	30	13,600	1,632	1,632	13,600****	1,632	1,632
Buffalo	450	3,150	5,670	5,670	2836****	5,105	5,105
Browsing Antelopes	40	2,654	425	425	2,654****	425	425
Elephant	1,725	300	2.070	2,070	300****	2,070	2,070
Rhinoceros	816	15	49	49	59****	193	193
Giraffe	750	1,666	4,998	4,998	1,666****	4,998	4,998
Warthog	45	250	45	45	250****	45	45
TOTAL	- -	- -	**488,886**	**122,110**		**602,544**	**235,477**

Note: One Large Herbivore Unit (LHU) = 250Kg; **** Boone *et al.*, 2002 (assumpton that populatons have

(Sou * NBS 2017; **NCAA[WS], 2017 *** NCAA[DS] 2017; * *et al.*, 2002) one

2.2.2.4. Rangeland Resources

Rangelands show long-term fuctuations in v due to overgrazing, fre, trampling and nu NCA rangelands are unstable in terms of response to changing rainfall, fre regime appear to be very resilient in terms of their tolerance to disturbance (Homewood and Rodgers, 1991). *Eleusine jaegeri tussocks* (Plate 1) are common in the highland areas and are often found on disturbed ground.

Plate 1: Eleusine Jaegeri tussocks in NCA r

Sour NCA GMP 2006–2016

2.2.2.5. Land Use and Land Cover Trends

Pratt and Gwyne (1966) identifed nine la
rangelands: bushlands, grasslands, crop lands, woodlands, forests, montane
health, barelands, shrubs and water bodies
used in determinIng land use and land cover trends for the NCA between 2000 and 2020 is adopted from the description of East Africa land cover by Pratt and Gwyne (1966). However, in this analysis, bushlands, montane health and shrubs are combined to one land cover class of bush lands, while forests and woodlands are classifed as dense forests and sparse
analysis is based on six major land cover types: dense forest, sparse forest, bushlands, grasslands, barelands and water bodies. The descriptions of land cover types for the NCA are shown in Table 2.

Table 2: Land cover categories

No.	Land cover categories	Description
1.	Dense Forests	Areas with closed canopy trees of one or more storeys, rising from 7 to ≥40 m in heigh dominate the ground.
2.	Sparse Forests	Area covered by trees with an open canopy surrounded by grassland and sometimes shrub but not thickets. These areas are sometimes dominated by only a few species of trees.
3.	Bushlands	Areas of woody plants, bushes or trees, with a closed and open canopy (shrubs and bushes) between 3 and 6 m in height and surrounded by grassland or dry land.
4.	Grasslands	Areas dominated by grasses <25 to 150 cm tall, sometimes with herbs, scarred trees or shrubs. These areas contain some woody cover and are almost bare during dry season.
5.	Water Bodies	Areas covered or saturated with water either permanent or seasonally. Includes lakes, rivers, dams and marshes.
6.	Barelands	Areas with minimal or no plant cover. They include built-up areas, bare rocks, sands, sal riverine deposits.

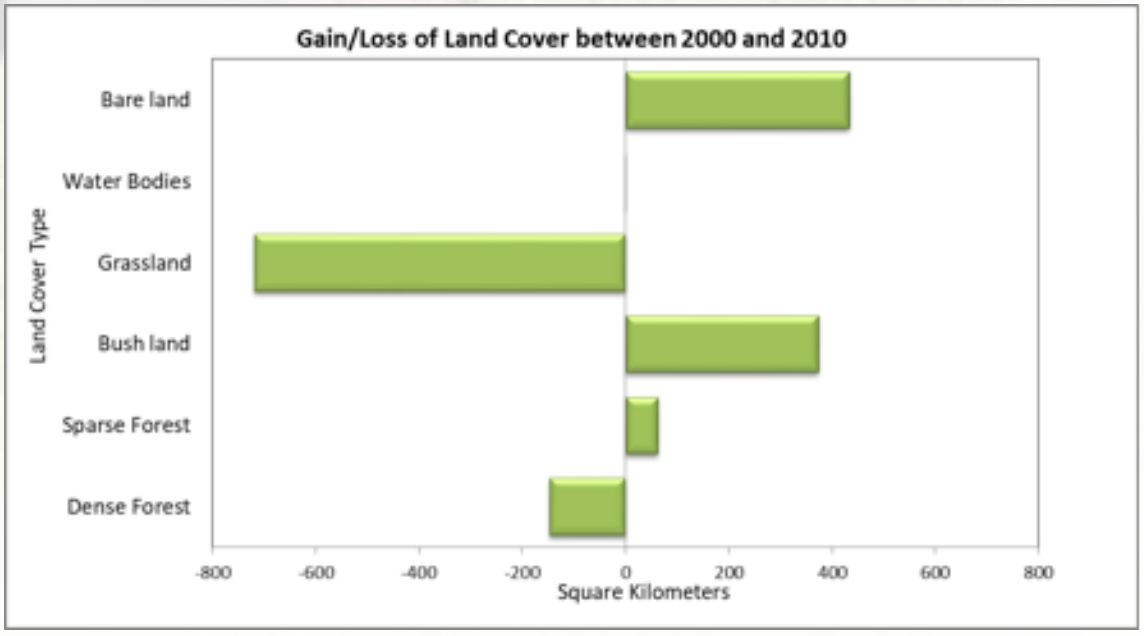
Sou rPcr ea :t *et a*lD, 1966

The analysis of land use/cover change between 2000 and 2010 indicates that area under dense forest, which occupied 1,294.26 Km² (15.9%), decreased to 1,146.26 Km² (14.08%), that is, 1.82%. Grasslands also decreased by 8.84% from 4,394.99 Km² (53.99%) to 3,675.7 Km² (45.15%). Water bodies experienced a slight decrease of 0.59 Km². At the same time, sparse forest and bushlands showed an increase from 460.85 Km² (5.66%) to 523.09 Km² (6.43%), and from 1291.51 Km² (15.87%) to 1664.5 Km² (20.44%) respectively, indicating the gain of about 0.77% and 4.57% respectively. Additionally, barelands increased by 5.32% from 631.8Km² (7.76%) to 1064.45 Km² (13.08%). Further description is presented in Table 3, Figure 5, Map 4 and Map 5.

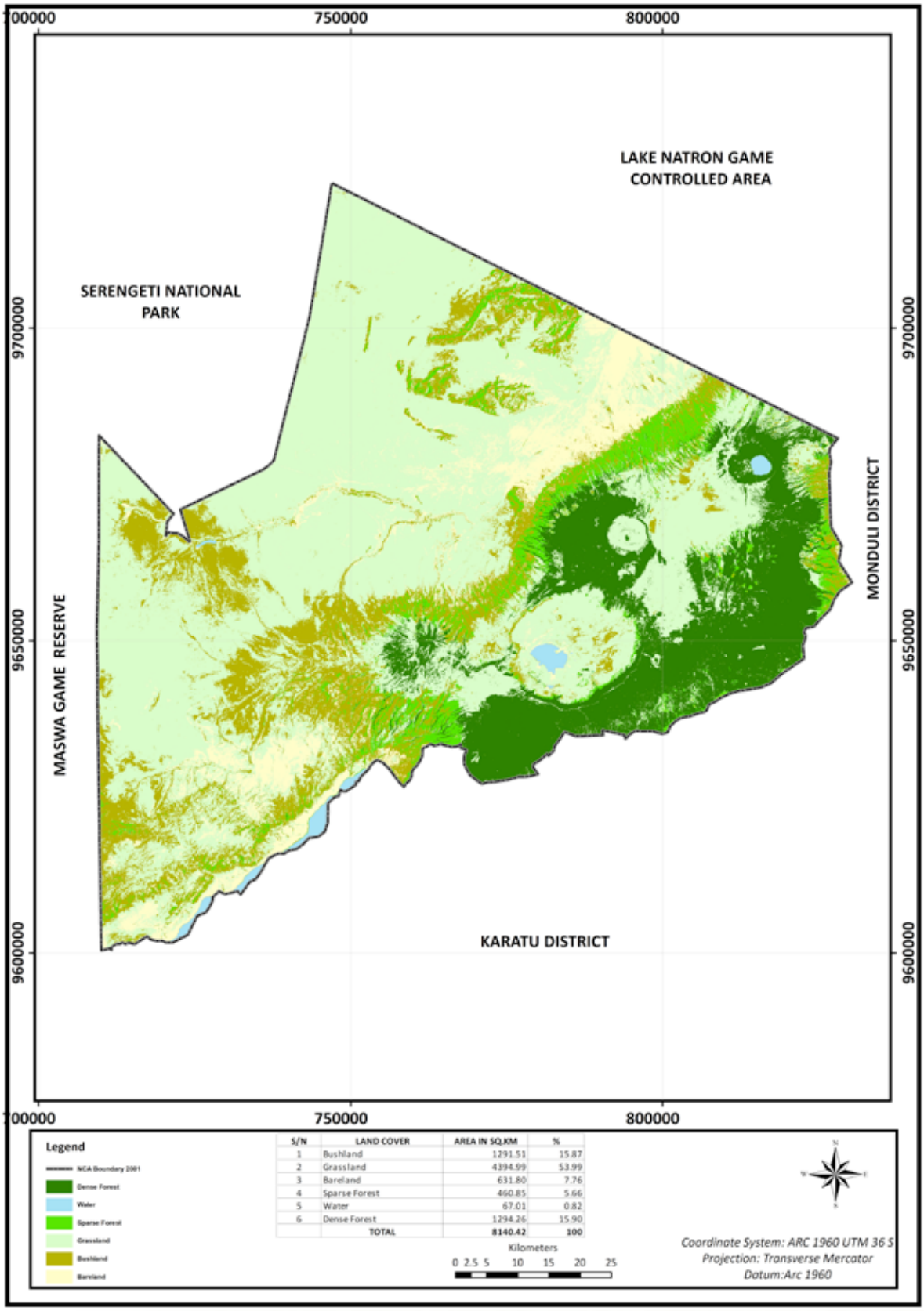
Table 3: Land use and land cover chang

No.	Land Cover Type	2000		2010		Area Change	Area Change	Annual Rate of Change
		Area (Km²)	Proportion (%)	Area (Km²)	Proportion (%)	(Km²)	(%)	(Km²)
1.	Dense forest	1294.26	15.9	1146.26	14.08	-148	-1.82	-14.80
2.	Sparse forest	460.85	5.66	523.09	6.43	62.24	0.77	6.24
3.	Bushlands	1291.51	15.87	1664.5	20.44	372.99	4.57	37.30
4.	Grasslands	4394.99	53.99	3675.7	45.15	-719.29	-8.84	-71.93
5.	Water bodies	67.01	0.82	66.42	0.82	-0.59	0	-0.06
6.	Barelands	631.8	7.76	1064.45	13.08	432.65	5.32	43.27
Total		**8140.42**	**100**	**8140.42**	**100**			

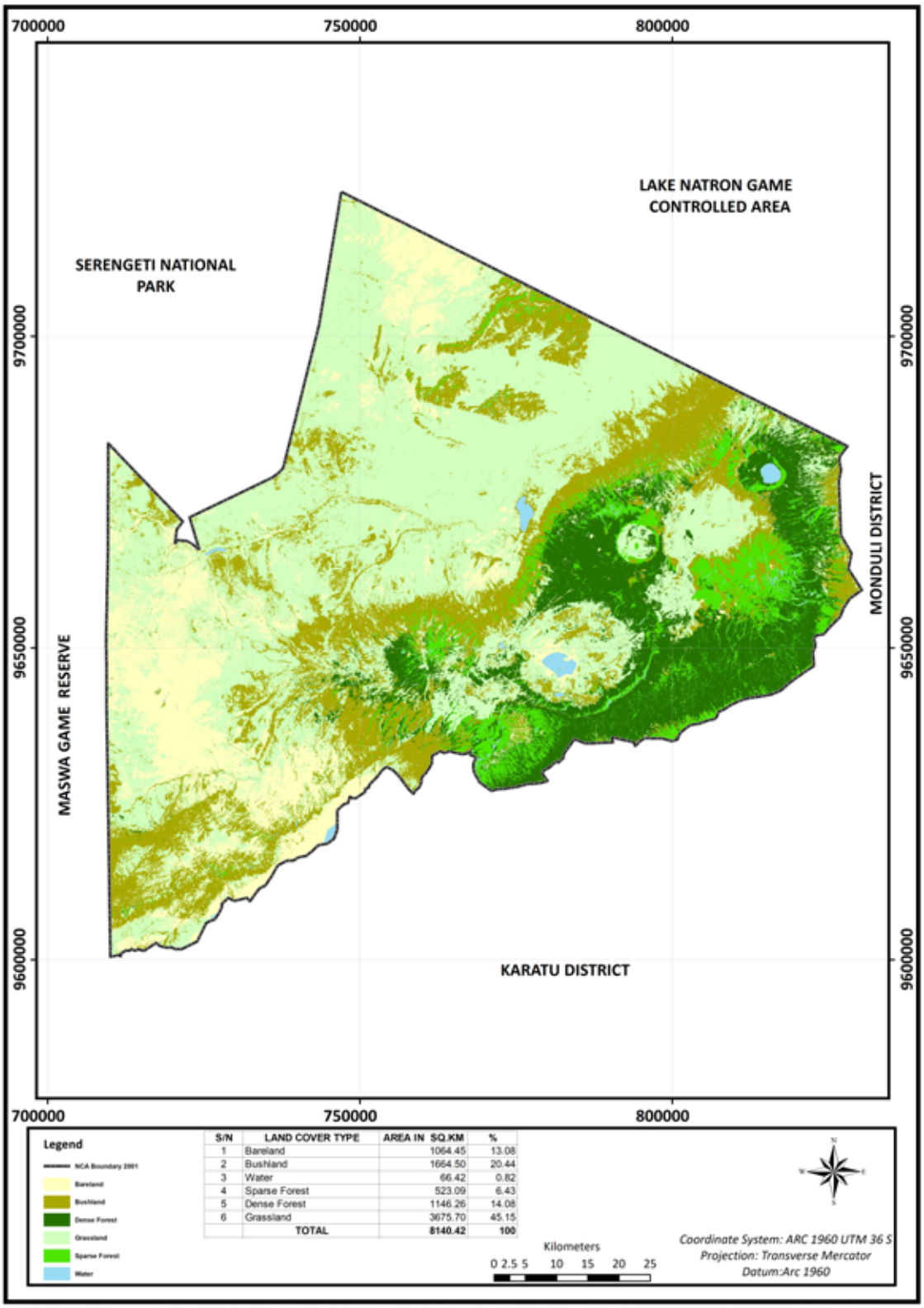
Figure 5: Gain and loss of land cover



Map 4: Land cover of Ngorongoro Conse



Map 5: Land cover of Ngorongoro Conse



For the period 2010–2020 (before boundary land cover change was observed as that of use/cover change between 2010 and 2020 shows that dense forest, grasslands, water bodies and barelands declined from 1146.26 Km² (14.08%), 3675.7 Km² (45.15%), 66.42 Km² (0.82%) and 1064.45 Km² (13.08%) to 1037.28 Km²

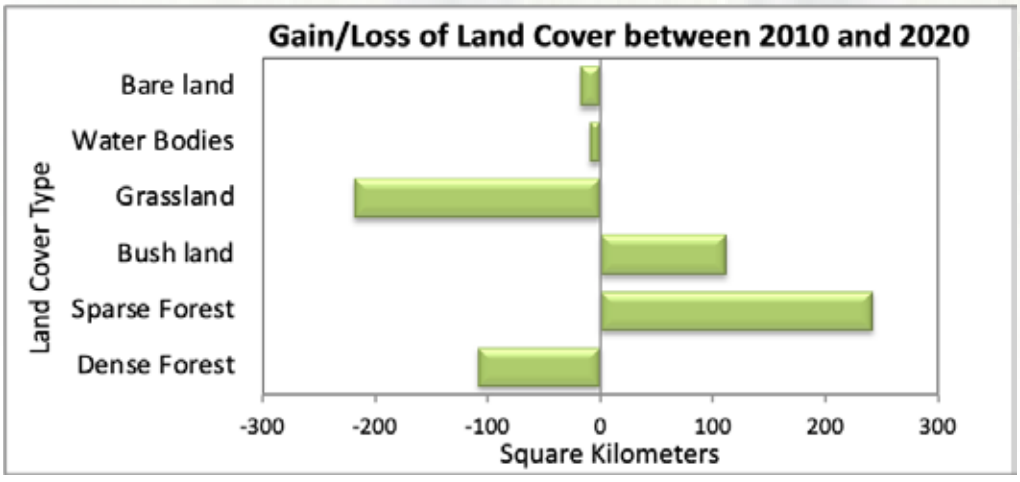
(14.74%), 3456.87 Km² (42.47%), 57.35 Km² (0.70%) and 1046.52 Km² (12.86%) respectively, indicating the percentage loss of 1.34%, 2.68%, 0.12% and 0.22% respectively. For the same period, sparse forests and bushlands increased from 523.09 Km² (6.43%) and 1664.5 Km² (20.44%) to 765.76 Km² (9.4%) and 1776.64 Km² (21.83%) respectively, a gain of 2.97% for sparse forest and 1.39% for bushlands. Further description is shown in Table 4, Figure 6, Map 5 and Map 6.

Table 4: Land use and land cover chang

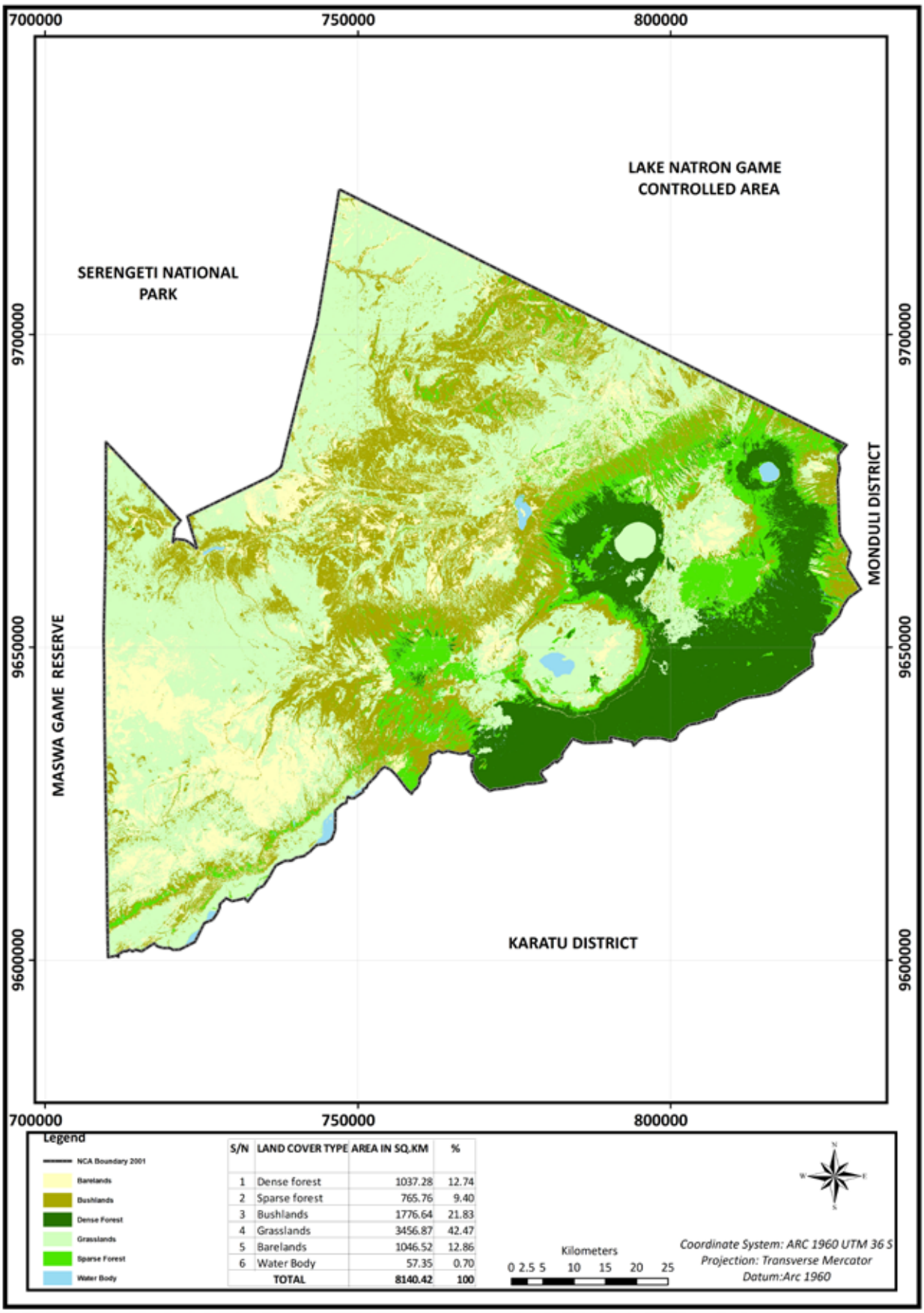
No.	Land Cover Type	2010		2020		Area Change	Area Change	Annual Rate of Change
		Area (Km²)	Proportion (%)	Area (Km²)	Proportion (%)	(Km²)	(%)	(Km²)
1.	Dense forest	1146.26	14.08	1037.28	12.74	-108.98	-1.34	-10.89
2.	Sparse forest	523.09	6.43	765.76	9.4	242.67	2.97	24.26
3.	Bushlands	1664.5	20.44	1776.64	21.83	112.14	1.39	11.21
4.	Grasslands	3675.7	45.15	3456.87	42.47	-218.83	-2.68	-21.88
5.	Water bodies	66.42	0.82	57.35	0.70	-9.07	-0.12	-0.91
6.	Barelands	1064.45	13.08	1046.52	12.86	-17.93	-0.22	-1.79
	Total	**8140.42**	**100**	**8140.42**	**100**			

Significant decrease in dense forest cover for timber, firewood, grazing, medicine and destroys the ecology of the area thus lowering provision of essential ecosystem services such as wildlife refuge and habitat, water and climate regulation. Grasslands in the NCA have also decreased due to climate change and variability as well as overgrazing of rangelands attributed to the high population of wild animals and livestock in the NCA. Thus, destruction of forests and grasslands creates a conducive environment for emergency/growth of shrubs and bushes in the NCA.

Figure 6: Gain and loss of land cover



Map 6: Land cover of Ngorongoro Conse



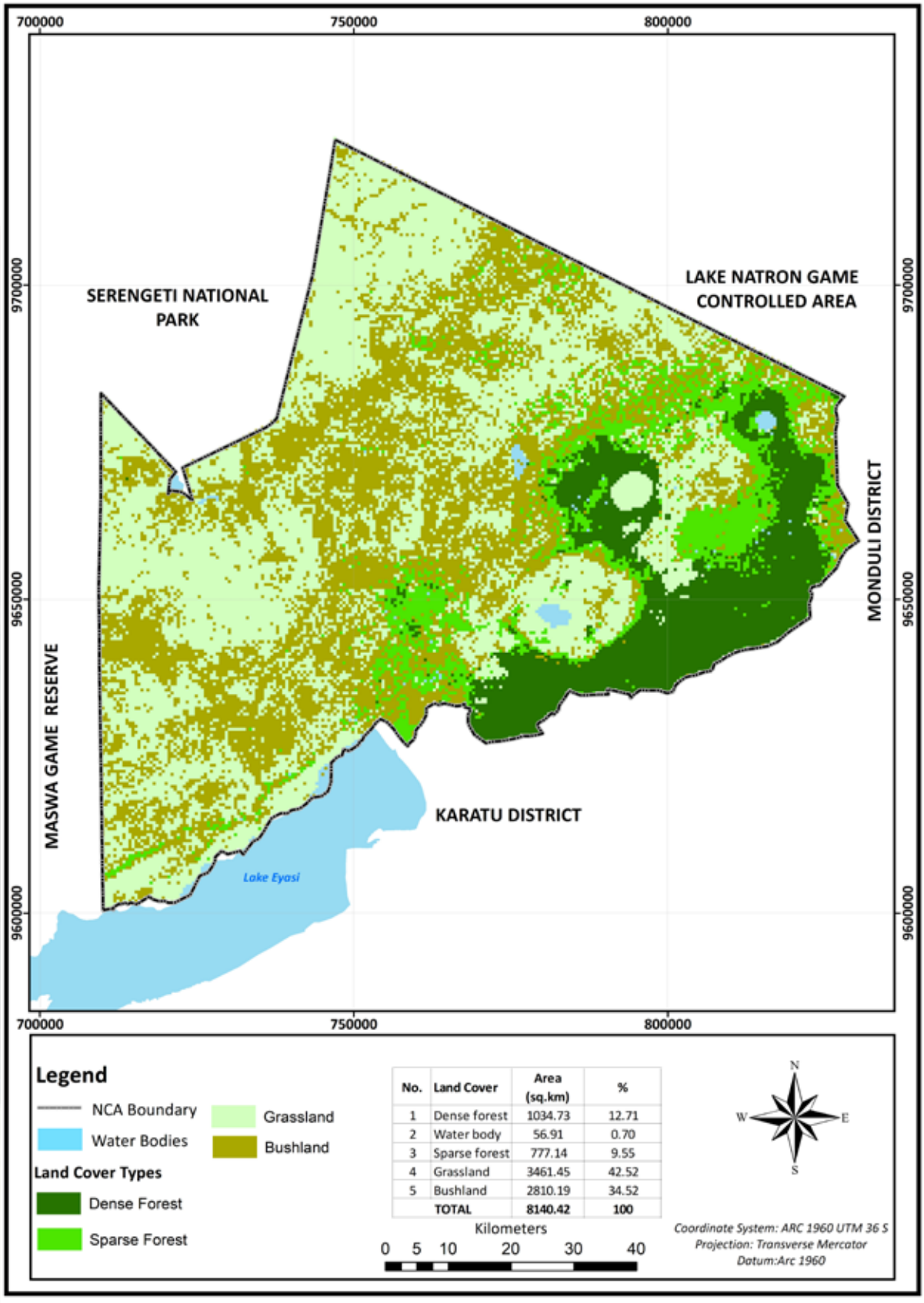
S/N	LAND COVER TYPE	AREA IN SQ.KM	%
1	Dense forest	1037.28	12.74
2	Sparse forest	765.76	9.40
3	Bushlands	1776.64	21.83
4	Grasslands	3456.87	42.47
5	Barelands	1046.52	12.86
6	Water Body	57.35	0.70
	TOTAL	8140.42	100

If similar environmental problems, which are currently being experienced in the NCA, were to continue, projections of changes of land use land cover for the period of 20 years from 2020 reveal that dense forest areas and water bodies will decrease from 1037.28 Km^2 (12.74%) to 1034.73 Km^2 (12.71%) and 57.35 Km^2 (0.70%) to 56.91 Km^2 (0.69%) respectively, thus indicating the percentage loss of 0.03% and 0.01% respectively. On the other hand, projections indicate that sparse forest areas, bushlands and grasslands will increase from 765.76 Km^2 (9.4 %) to 777.14 Km^2 (9.55%), 1776.64 Km^2 (21.83%) to 2810.19 Km^2 (34.52) and 3456.87 Km^2 (42.47%) to 3461.45 Km^2 (42.52%) respectively, thus indicating the percentage gain of 0.15%, 12.69% and 0.05% respectively. Further description is shown in Table 5, Map 6 and Map 7.

Table 5: Land use and land cover chang

No.	Land Cover Type	2020		2040		Area Change	Area Change	Annual Rate of Change
		Area (Km^2)	Proportion (%)	Area (Km^2)	Proportion (%)	(Km^2)	(%)	(Km^2)
1	Dense forest	1037.28	12.74	1034.73	12.71	-2.55	-0.03	-0.127
2	Sparse forest	765.76	9.4	777.14	9.55	11.38	0.15	0.57
3	Bush lands	1776.64	21.83	2810.19	34.52	1033.6	12.69	51.67
4	Grasslands	3456.87	42.47	3461.45	42.52	4.58	0.05	0.23
5	Water bodies	57.35	0.70	56.91	0.69	-0.44	0.01	-0.02
6	Bare land	1046.52	12.86	-	-	-	-	-
Total		**8140.42**	**100**	**8140.42**	**100**			

Map 7: Projectons for land cover of the N



No.	Land Cover	Area (sq.km)	%
1	Dense forest	1034.73	12.71
2	Water body	56.91	0.70
3	Sparse forest	777.14	9.55
4	Grassland	3461.45	42.52
5	Bushland	2810.19	34.52
	TOTAL	8140.42	100

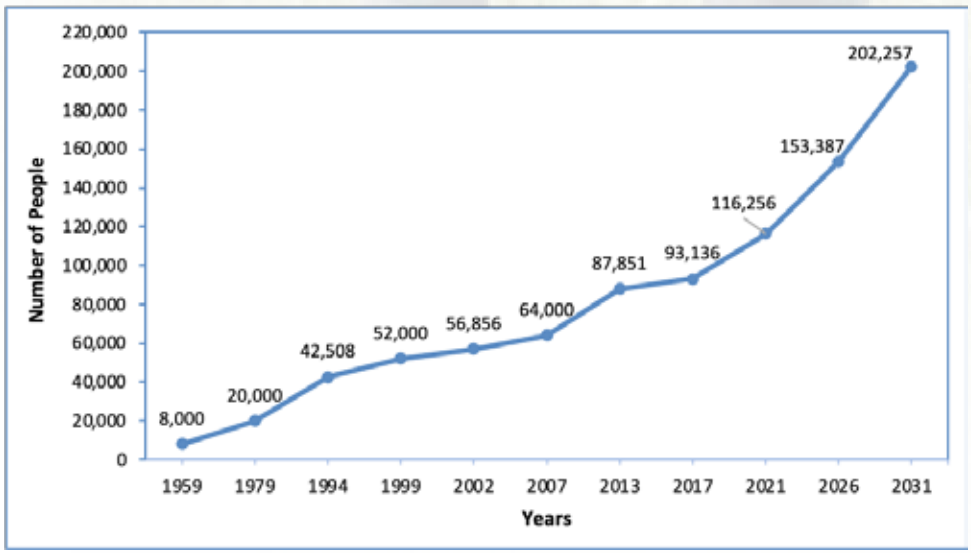
2.3 Socio-Economic Trends

2.3.1 Human Population

During its establishment in 1959, the NCA had 8000 inhabitants, who migrated from Serengeti National Park. Since then, there has been an increasing population of people in the area. Natural growth in the number of NCA indigenous residents, non-residents who remain in the conservation area after they have retired, small business people and their families and immigrants, who are attracted by favourable grazing conditions, veterinary services and employment opportunities, all account for fast human population growth in the NCA. Rapid human immigration in the 1970s led to a sharp increase in population in the NCA. By the early 2000s, the human populat compared with that of 1959 (TAWIRI, 2020). The population rose dramatically from about 42,000 in 1994 to approximately 64,000 in 2007. However, there was a notable decline of people in 2012 caused by voluntary relocation of people from the NCA to Jema village in Sonjo between 2007 and 2010, and drought, which affected the area and forced pastoralists to migrate.

Despite interventions to control population growth, a human and livestock population census conducted in the NCA in 2017 revealed a population of 93,136, an increase of almost 30,000 people for an interval of 10 years. Considering the NCA growth rate of 5.7 per year, the population is currently estimated to be 116,256. Projections for 2026 and 2031 show that the number of inhabitants will be 153,387 and 202,257 respectively. The population creates demands for living space and environmental services, which are in direct competition with wildlife and lead inevitably to environmental degradation. Further description is shown in Figure 7.

Figure 7: Trends of human populaton in



(Sour NBS, 2002, 2013 and 2017)

2.3.2 Human Settlements

Eight thousand NCA inhabitants who migrated from Serengeti National Park in 1959 were settled in Enduleni, Naspooriong, Kaitakiteng, Loongojok, Oloirobi, Kayepus and Mokilal. In 1960, the approximate total area of human settlements in the NCA was 46.8 hectares of land. This increased to 192.2 hectares in 1980 with new settlement areas being established in Olpiro, Iltulele, Naiyobi, Irkeepus, Nainokanoka, Kakesio, Bulati and Alailelai. By 2000, new settlements had already been established in Alaitole, Esere, Masamburai, Ngoile, Meshil, Osinoni, Alchaniomelok, Sendui, Kapenjiro and Misigiyo. The approximate total settlement area in this year was almost 79 times (3699.7 hectares) the total size in 1960. By 2020, further expansion of settlement areas within these 25 settlements increased the total settlement area of the NCA to 8,631.7 hectares of land, which was 2.3 times the established size in 2000 and equivalent to 1.06% of the total conservation area. These areas for human settlement also have other uses including education (primary and secondary schools), health (hospitals and dispensaries), infrastructures (water of these settlement units are linear, unplanned and built along roads and major resource areas such as the Northern Highland Forest Reserve, Shifting Sand, Oldupai Gorge, Alaitole footprints area and the crater areas (Ngongoro, Olmoti and Empakai). Further description is shown

2.3.2.1 Settlement Patterns

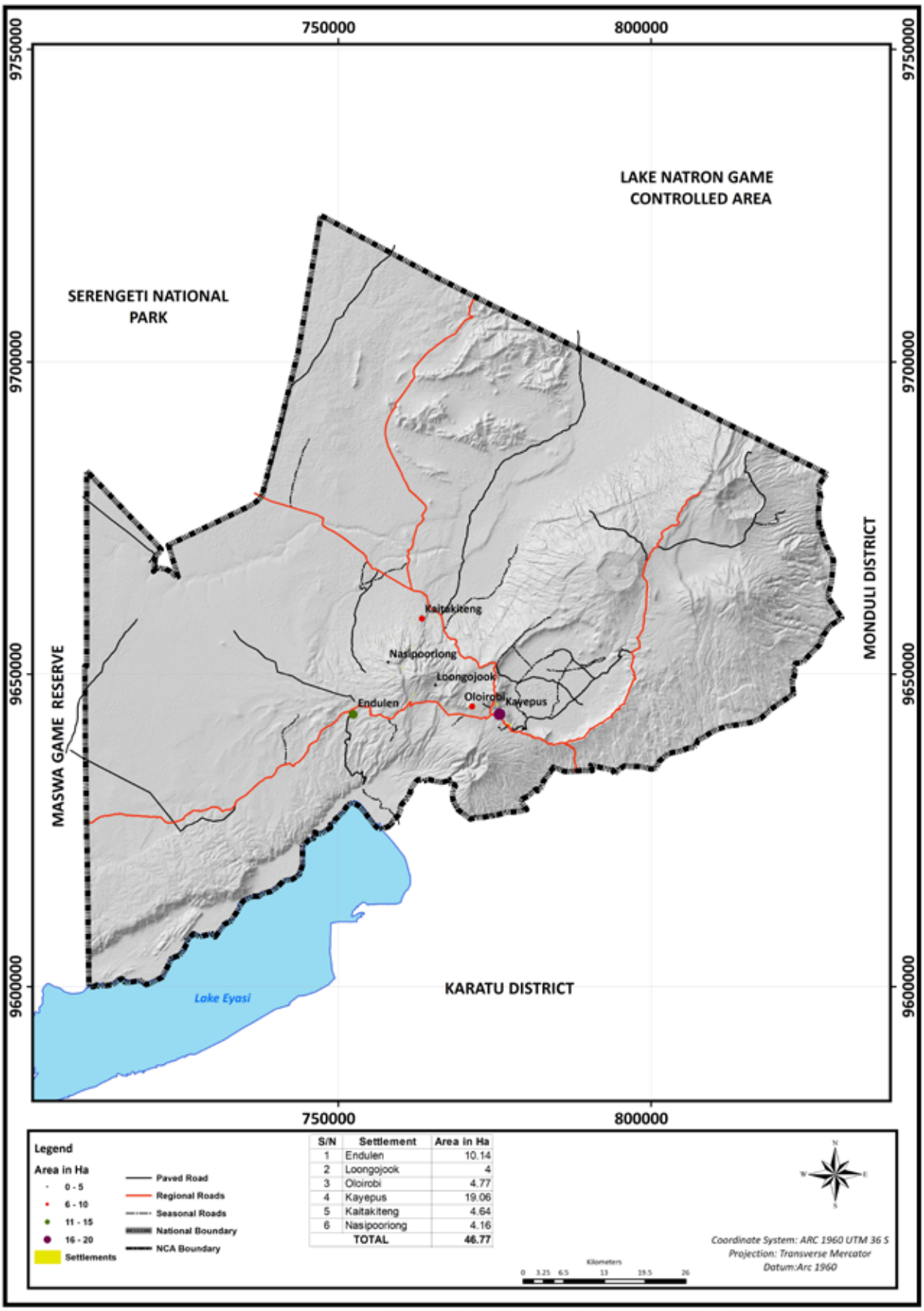
Settlement patterns in the NCA are classif units, minor settlement units and temporary settlement units (loonjor). Major settlement units are more developed, concentrated, serve as trading centres and have a relatively higher population density. Minor settlement units are less concentrated and developed residence areas, which are found adjacent to major settlement units with relatively lower population densities. Temporary settlement units are not localised, seasonal and are particularly inhabited during dry seasons when water and pasture are scarce, and pastoralists are in search of the same for their livestock. Factors that have contributed to the hierarchical development growth pattern of these settlement units are total number of populations, terrain, availability of natural resources (proximity to water and pasture lands) and availability of social service facilities and infrastructures. In most settlement units, grazing activities are also carried out.

Table 6: NCA settlements development tren

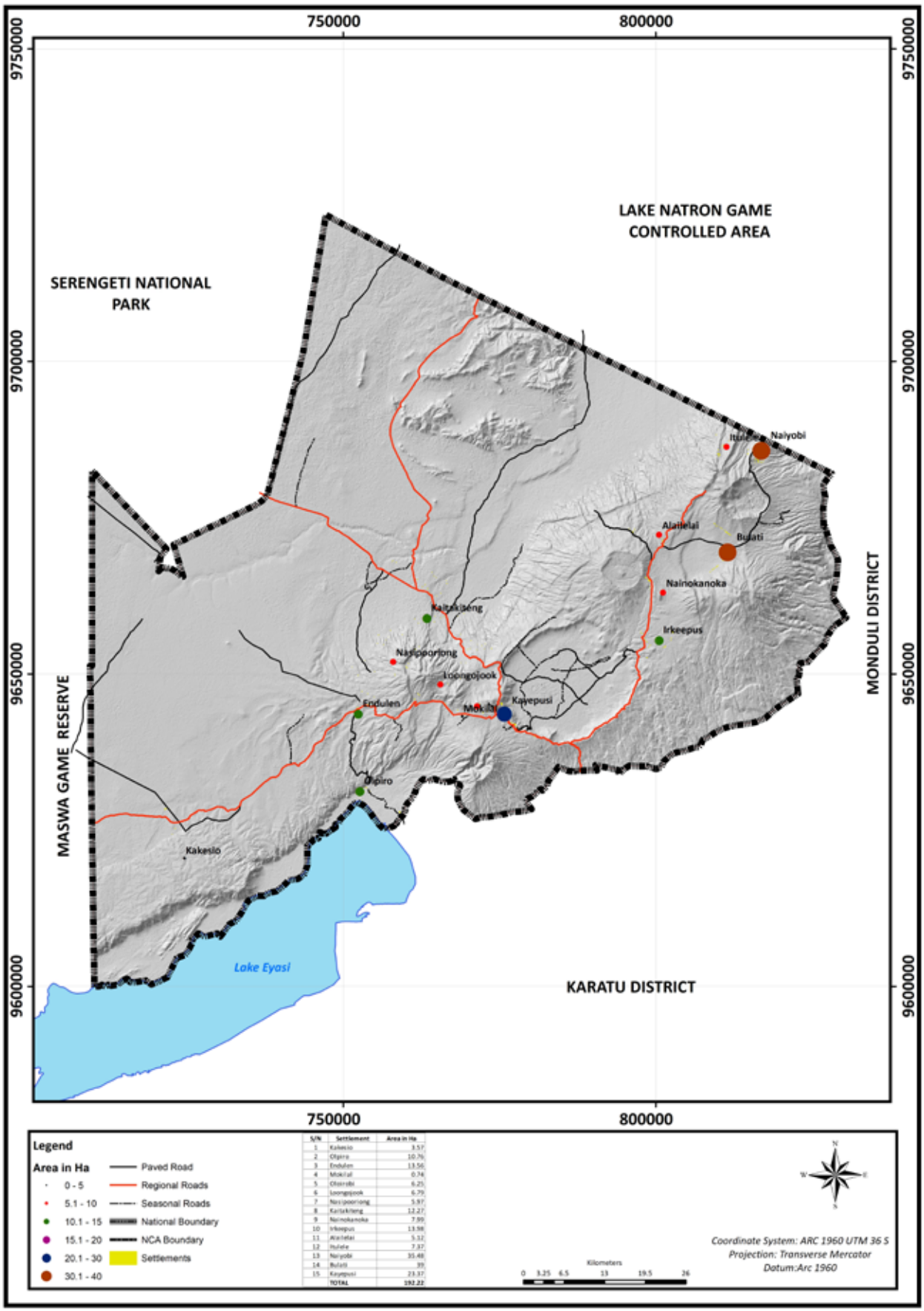
No.	Setlement Name	Setlement Area in Hectares				
		1960	1980	2000	2020	2040
1.	Endulen	10.14	13.56	464.74	825.55	1725.18
2.	Nasipooriang	4.16	5.97	92.74	232.72	403.34
3.	Kaitakiteng	4.64	12.27	32.39	158.66	206.55
4.	Alaitole	0	0.00	62.8	168.52	294.12
5.	Esere	0	0.00	14.86	271.92	301.64
6.	Masamburai	0	0.00	48.44	521.18	618.06
7.	Olpiro	0	10.76	43.33	358.1	462.09
8.	Osinoni	0	0.00	54.55	301.69	410.79
9.	Ngoile	0	0.00	226.26	409.89	862.41
10.	Meshil	0	0.00	169.01	231.69	569.71
11.	Alchaniomelok	0	0.00	143.63	197.63	484.89
12.	Sendui	0	0.00	139.37	197.93	476.67
13.	Itulele	0	7.37	16.43	62.3	105.41
14.	Naiyobi	0	35.48	287.88	493.76	969.62
15.	Kapenjiro	0	0.00	68.7	148.55	285.95
16.	Irkeepus	0	13.98	249.13	367.95	831.31
17.	Nainokanoka	0	7.99	590.58	993.86	2153.51
18.	Kakesio	0	3.57	171.13	343.19	674.64
19.	Mokilal	0	0.74	277.7	399.17	952.77
20.	Bulat	0	39.00	57.67	496.66	1413.67
21.	Alailelai	0.0	5.12	42.82	424.31	872.21
22.	Oloirobi	4.77	6.25	151.9	486.12	774.02
23.	Kayepusi	19.06	23.37	84	232.67	343.36
24.	Loongjook	4.0	6.79	64.5	116.25	229.17
25.	Misigiyo	0	0.00	145.12	191.39	481.63
Total		**46.8**	**192.22**	**3,699.7**	**8,631.7**	**16,902.72**

Considering the average annual increase in the size of human settlements between different periods from 1960 to 2020, and assuming that the rate is maintained, it is projected that the total human settlements area will increase to 16,902.72 hectares of land in 2040, which is equivalent to 1.95% of the total conservation area. This implies that the NCA will continue to experience increasing human settlement at the expense of other land resoures in the area. Further description is shown in Map 12.

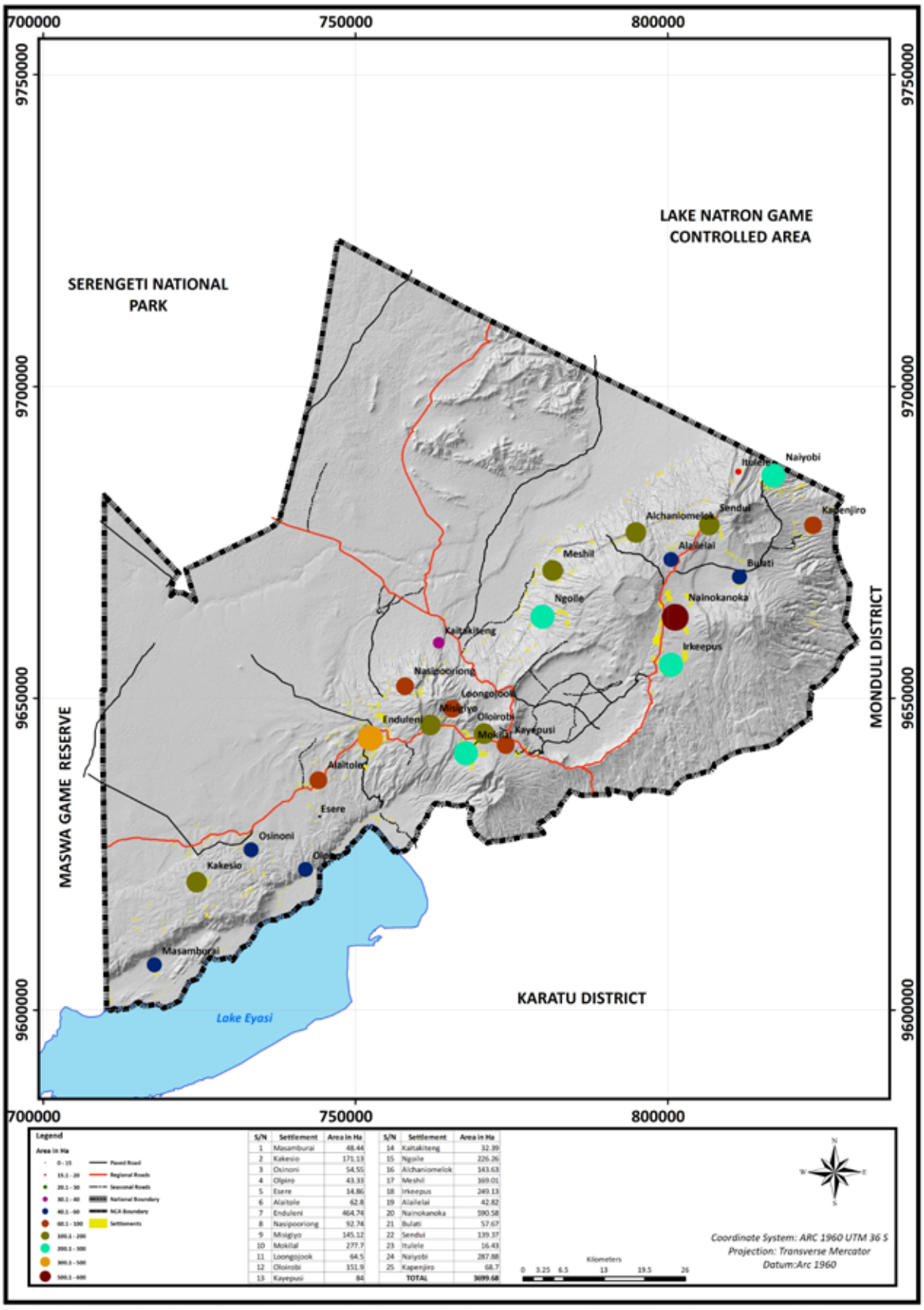
Map 8: NCA Setlements distributon



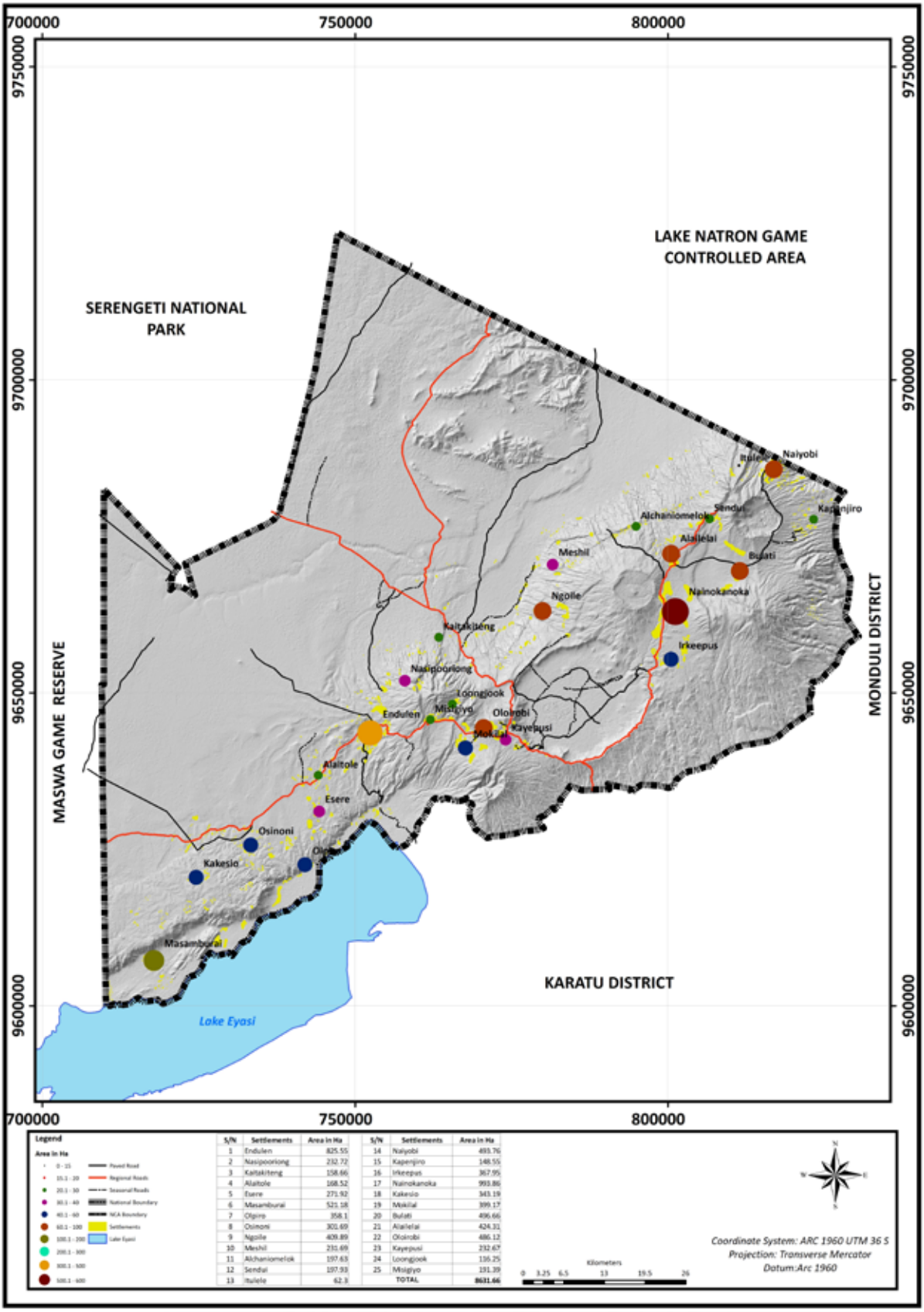
Map 9: NCA setlements distributon



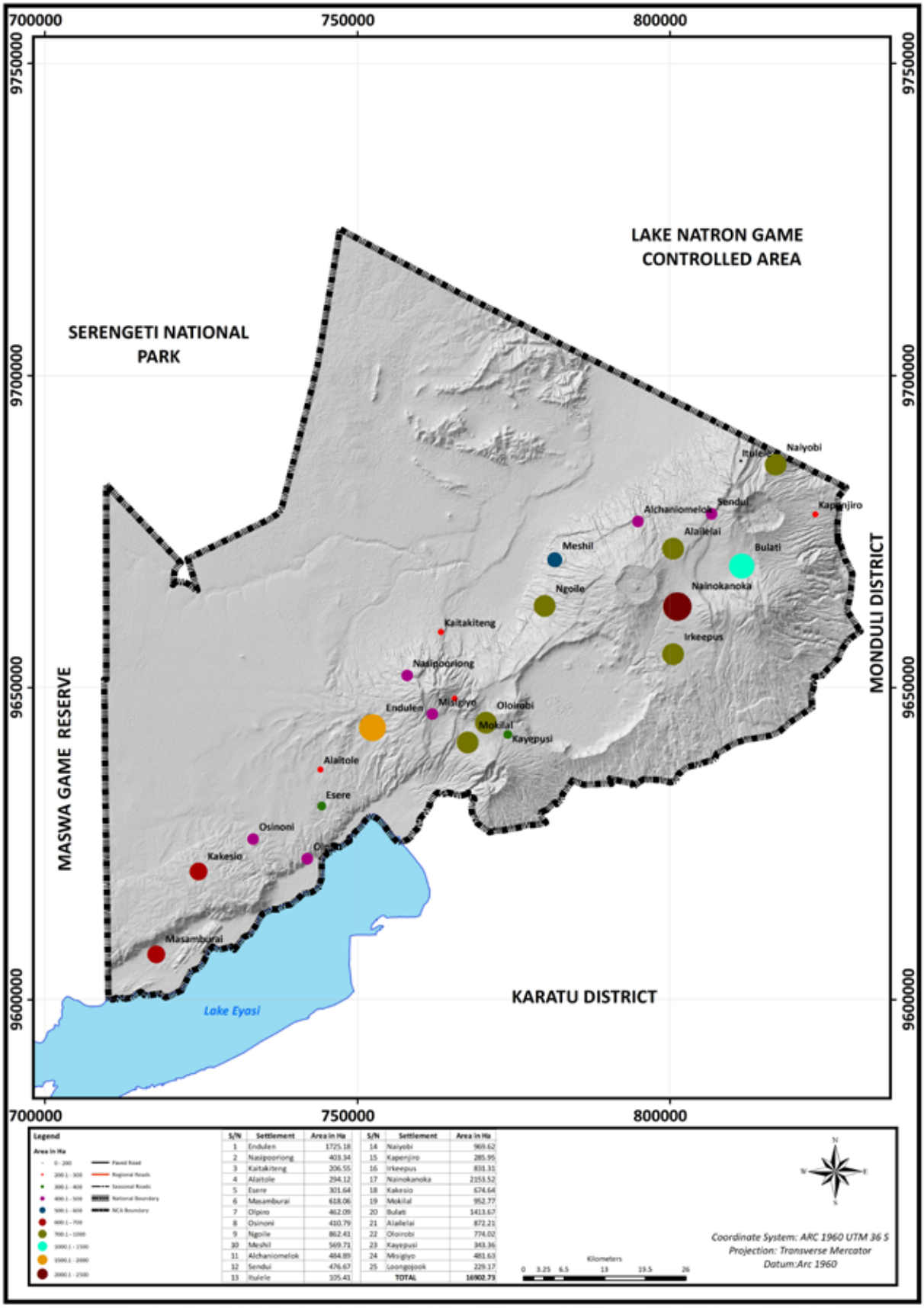
Map 10: NCA setlements distributon



Map 11: NCA setlements distributon



Map 12: Projected NCA setlements ar



S/N	Settlement	Area in Ha	S/N	Settlement	Area in Ha
1	Endulen	1725.18	14	Naiyobi	969.62
2	Nasipooriong	403.34	15	Kapenjiro	285.95
3	Kaitakiteng	206.55	16	Irkeepus	831.31
4	Alaitole	294.12	17	Nainokanoka	2153.52
5	Esere	301.64	18	Kakesio	674.64
6	Masamburai	618.06	19	Mokilal	952.77
7	Olpiro	462.09	20	Bulati	1413.67
8	Osinoni	410.79	21	Alailelai	872.21
9	Ngoile	862.43	22	Oloirobi	774.02
10	Meshil	569.71	23	Kayepusi	343.36
11	Alchaniomelok	484.89	24	Misigiyo	481.63
12	Sendul	476.67	25	Loongojook	229.17
13	Itulele	105.41		TOTAL	16902.73

2.3.3. Livestock Population

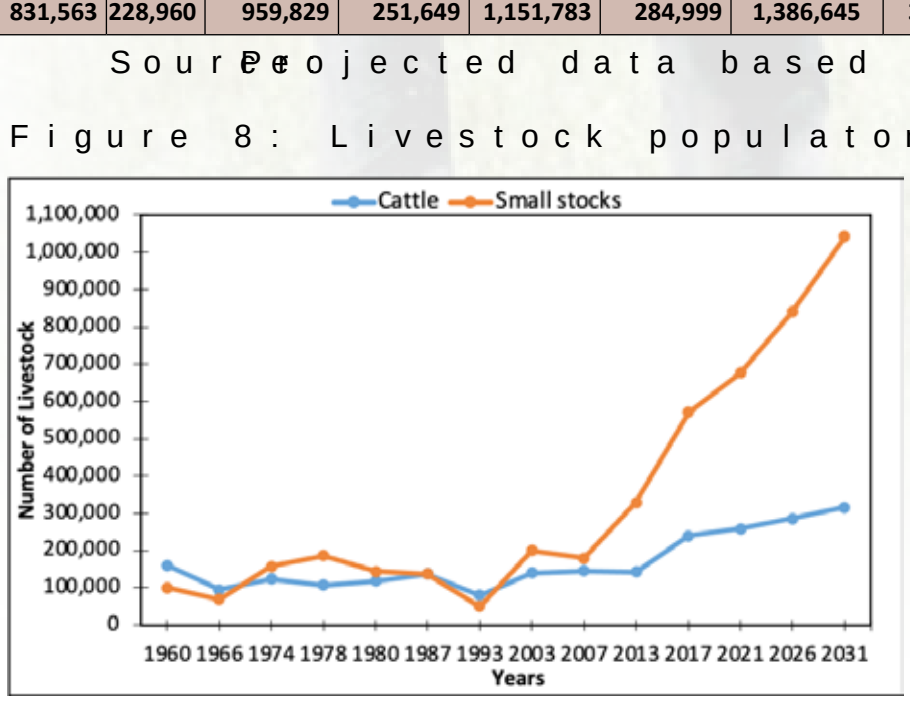
Immediately after the establishment of the NCA in 1960, the number of cattle increased steadily, with decline in some years from 161,034, and reached 238,826 in 2017. Small stocks increased steadily, with decline in some years from 100,689, and reached 570,633 by 2017 (Kijazi et al., 1997; NBS, 2017). Other livestock types include donkeys (22,104), chickens (6,497), pigs (225) and camels (48) (NBS, 2017). Considering the annual growth rate of 2% for cattle, 3.86% for sheep and 5.1% for goats, livestock projections show that the NCA currently (year 2021) has 959,829 livestock, which is equivalent to 251,649 TLUs. This number is projected to increase to 1,386,645 (322,939 TLUs) in 2031. Increase in livestock number requires more grazing land and livestock services. Considering also the carrying capacity of the area, a total of 322,939 X 7 = 2,260,573 hectares (which is 272.6% of the total land (area) of the NCA) will be required for livestock grazing in 2031. This means that, besides the land requirement for settlement and other uses, the area required for grazing only at that time will be almost three times as much as the total area of the NCA. Further description is shown in Table 7 and Figure 8.

Table 7: Livestock projections in the NC

No.	Type of Livestock	2017		2021		2026		2031	
		Number	TLU	Number	TLU	Number	TLU	Number	TLU
1	Cattle	238,826	171,955	258,513	186,129	285,419	205,502	315,126	226,891
2	Donkey	22,104	15,919	23,926	16,748	26,416	19,020	29,165	20,999
3	Goats	226,260	16,291	276,070	19,877	35,4024	25,490	453,990	32,687
4	Sheep	344,373	24,795	401,320	28,895	485,924	34,987	588,364	42,362
Total		**831,563**	**228,960**	**959,829**	**251,649**	**1,151,783**	**284,999**	**1,386,645**	**322,939**

Source: Projected data based on NBS Cen

Figure 8: Livestock populaton trends i



2.3.4. Tourism

Tourism development in the NCA is determined by increasing numbers of visitors and revenues accrued from tourism activities. Records show that, since its establishment, revenues from tourism activities have generally increased with growing number of visitors. The total revenue has shown an increasing trend over the years; for instance, from TZS 70,7 2016 to TZS 143,469,808,000 in the financia average increase of approximately TZS 24.3 billion per year. This is attributed to more tourists visiting the area. However, revenue trend shows a decline in the financial year 2019–20 due to a reduced COVID-19 pandemic. Further description is presented in Table 8 and Figure 9.

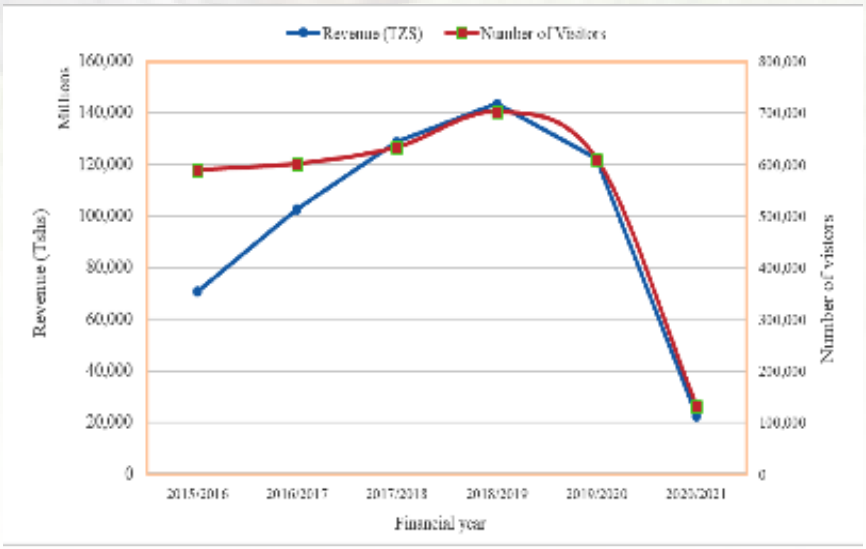
Table 8: Tourism revenue of the NCAA be

Financial Year	Number of Visitors (Residents and Non-Residents)	Revenue (TZS)
2015/2016	589,381	70,705,588,375
2016/2017	601,215	102,761,710,397
2017/2018	633,069	128,818,053,423
2018/2019	701,498	143,469,808,000
2019/2020	609,973	122,332,176,242
July 2020 – Feb 21	131,201	22,460,300,564.71

Source: NCAA, 2021

Although much of the revenues are accrued from foreign visitors to the NCA, the number of resident visitors has been increasing since 2016 as shown in Figure 9.

Figure 9: Revenue and tourists trends in



Source: NCAA, 2021

CHAPTER THREE: EXISTING NCA CONDITIONS

3.1 Socio-Economic Conditions

The socio-economic conditions of the NCA are demography, social services, facilities and economic activities. These conditions are further discussed in the following sub-sections.

3.1.1 Demography

3.1.1.1 Population

According to the 2017 Population and Livestock Census in Ngorongoro Division (NBS, 2017), the total population of people in Ngorongoro Division was 93,136 (Table 9), of which 51.6% (48,025) were female and 48.4% (45,111) were male.

Table 9: Populaton of NCA by ward

No.	Name of Ward	Populaton 2017		
		Male	Female	Total
1.	Olbalbal	3,459	3,865	7,324
2.	Ngoile	3,015	3,187	6,202
3.	Ngorongoro	4,946	4,896	9,842
4.	Misigiyo	3,012	3,125	6,137
5.	Endulen	5,672	5,990	11,662
6.	Alaitolei	2,327	2,450	4,777
7.	Eyasi	1,516	1,501	3,017
8.	Kakesio	3,017	3,293	6,310
9.	Nainokanoka	6,747	7,419	14,166
10.	Alailelai	5,001	5,249	10,250
11.	Naiyobi	6,399	7,050	13,449
Total		**45,111**	**48,025**	**93,136**

Source: NBS, 2017

3.1.1.2 Household Characteristics

Until 2017, the NCA had a total of 20,866 private households, 54% of which were headed by males and 46% by females. The average household size was 4.5 (Table 10). The census report by NBS (2017) has further shown that 45% of private households in the NCA use piped water as their main source of drinking water. Piped water includes water piped into houses, piped into a yard and public tap. Firewood is the main source of energy for cooking in the NCA, used by 95% of the households. Other sources, including electricity, gas, charcoal and animal residuals, account for only 5% of households, while 55% of all households use touch/rechargeable lamps as their main sources of energy for lighting.

Table 10: Number of households and average
2018

No.	Wards	Populaton 2017	No. of Household 2017	Average Household Size 2017	No. of Households 2018
1.	Olbalbal	7,324	1,709	4.3	2,044
2.	Ngoile	6,202	1,439	4.3	1,596
3.	Ngorongoro	9,842	2,231	4.4	2,579
4.	Misigiyo	6,137	1,242	4.9	730
5.	Endulen	11,662	2,463	4.7	3,850
6.	Alaitolei	4,777	1,066	4.5	1,652
7.	Eyasi	3,017	629	4.8	684
8.	Kakesio	6,310	1,364	4.6	2,090
9.	Nainokanoka	14,166	3,283	4.3	4,053
10.	Alailelai	10,250	2,262	4.5	2,981
11.	Naiyobi	13,449	3,202	4.2	9,997
Total		**93,136**	**20,890**	**4.5**	**32,256**

Source: NBS, 2017

3.1.1.3. Age and Sex Structure

The census survey consucted by the NBS in 2017 has shown that, the population of Ngorongoro Division is characterised by a young age structure, with 49.48% of the total population below 15 years of age. Kakesio ward had the largest proportion of young people (51.89%), while Ngorongoro ward had the smallest proportion (47.08%). According to internat proportion of youth (age 15 to 24 years) in Ngorongoro Division is 18.97% of the total population. Misigiyo ward has the large population (20.24%) of youth, while the smallest proportion is in Eyasi ward (17.77%). In addition to that, the Tanzania National Youth Policy defnes yout The proportion of people age 15 to 35 years in Ngorongoro Division is 33.77%. The ward with a larger proportion is Olbalbal (35.25%), and the smallest is Kakesio ward with 31.54% (NBS, 2017)

Table 11: Populaton by age groups b

No.	Name Ward	Populaton by Age Groups by Ward						
		of 0-14		15-64		65+		All Ages
		Male	Female	Male	Female	Male	Female	Both Sexes
1	Olbalbal	1,770	1,905	1,622	1,864	67	96	7,324
2	Ngoile	1,582	1,540	1,364	1,550	69	97	6,202
3	Ngorongoro	2,288	2,346	2,523	2,394	135	156	9,842
4	Misigiyo	1,549	1,550	1,374	1,485	89	90	6,137
5	Endulen	2,847	2,812	2,675	2,951	150	227	11,662
6	Alaitolei	1,211	1,162	1,060	1,214	56	74	4,777

7	Eyasi	771	733	698	689	47	79	3,017
8	Kakesio	1,625	1,649	1,282	1,516	110	128	6,310
9	Nainokanoka	3,354	3,413	3,206	3,772	187	234	14,166
10	Alailelai	2,611	2,511	2,266	2,598	124	140	10,250
11	Naiyobi	3,428	3,428	2,787	3,455	184	167	13,449
	Total	**23,036**	**23,049**	**20,857**	**23,488**	**1,218**	**1,488**	**93,136**

Source: NBS, 2017

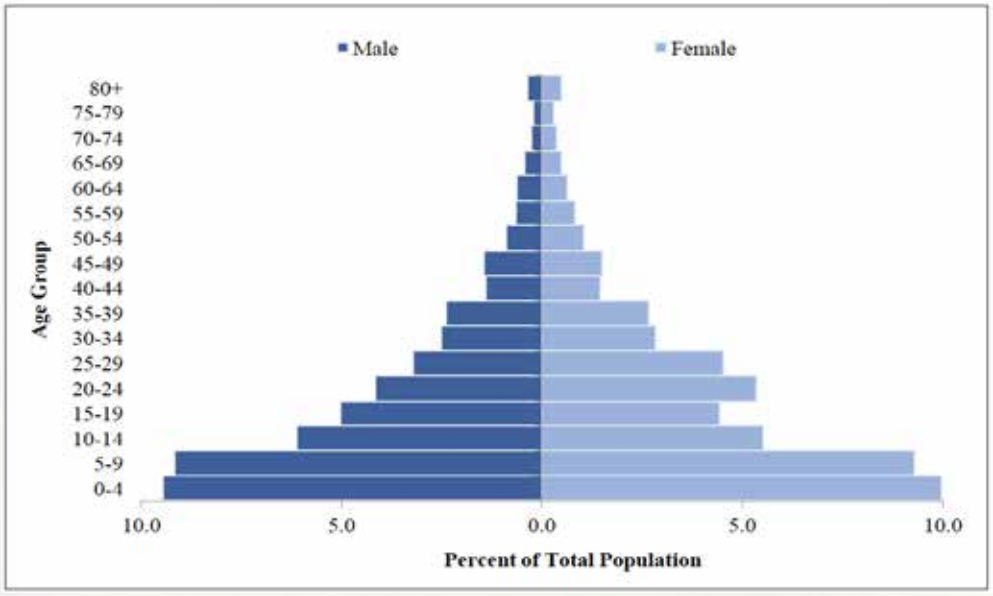
3.1.1.4 Age Dependency Ratio

Overall, the age dependency ratio for all wards in the NCA is above 100%. That is, the NCA community has a large number of dependents compared with the number of people able to work (working age). The working age of any population, referred to as the economically productive population, comprises people aged 15 to 64 years. The proportion of working age population in Ngorongoro Division is 47.61% (46.23% for males and 48.91% for females). In the case of elderly people, the result shows that 4.15% of Ngorongoro Division population is aged 60 years or above. The percentages of the total population, which constitutes the elderly aged 60 years or above and 65 years or above, are indicators of population ageing.

Table 12: Age dependency rato for both

No.	Name of Ward	Dependency Age Groups		Working Age Groups	Age Dependency
		0-14	65+	Total 15-64	Rato
1	Olbalbal	3,675	163	3,838	3,486	110.1
2	Ngoile	3,122	166	3,288	2,914	112.8
3	Ngorongoro	4,634	291	4,925	4,917	100.2
4	Misigiyo	3,099	179	3,278	2,859	114.7
5	Endulen	5,659	377	6,036	5,626	107.3
6	Alaitolei	2,373	130	2,503	2,274	110.1
7	Eyasi	1504	126	1,630	1387	117.5
8	Kakesio	3,274	238	3,512	2,798	125.5
9	Nainokanoka	6,767	421	7,188	6,978	103.0
10	Alailelai	5,122	264	5,386	4,864	110.7
11	Naiyobi	6,856	351	7,207	6,242	115.5
Total		**46,085**	**2,706**	**48,791**	**44,345**	**110.0**

Figure 10: Populaton pyramid (5-year age g



Sou NBS, 2017

3.1.2 Social Services and Facilities

3.1.2.1 Education Services and Literacy

Until 2017, the NCA had a total of 25 primary schools located in 21 settlements, and two secondary schools located in Endulen and Nainokanoka. Almost every settlement had a primary school, with the exception of Masamburai, Loongojok, Laitole and Kaitakiteng settlements, which did not have any primary or secondary school.

According to the NBS Census Report (2017), 35.8% of the population aged fve years or above in the NCA were litera 44.4% compared with 27.8% of females. This meant that 72.2% of females were illiterate. According to the NBS, the highest literacy rate was observed in Ngorongoro ward (50.3%), and the lowest was in Alailelai (24.7%). Generally, in all wards, males were much more literate than females, except in Eyasi ward where there was a small difference between males and females. Results further revealed that the literacy rate for younge decreased as age increased.

Plate 2: Sendui and Kakesio primary sc

Sendui Primary School

Kakesio Primary School

Primary schools are located in or near all major settlements in the NCA. These are the following:

Meshil (2)	Esere	Misigiyo	Irkeepus (2)
Ngoile (2)	Endulen	Alailelai	Bulati
Olpiro	Nasipooriong	Sendui	Naiyobi
Mokilal	Iltulele	Alchaniomelok	Kapenjiro
Oloirobi	Kayepus	Nainokanoka	Kakesio (2)
Osinoni			

3.1.2.2. Health Services

Major health facilities available in the NCA include a hospital, health centres and dispensaries, which are privately or government owned. One hospital, run by the Roman Catholic Mission, is located at Endulen (Plate 3), and it runs mobile clinics throughout the area. There are 14 dispensaries located in Meshil, Ngoile, Mokilal, Oloirobi, Kakesio, Kayepus, Esere, Nasipooriong, Misigiyo, Alchaniomelok, Nainokanoka, Irkeepus, Alailelai, Bulati and Naiyobi. According to the NBS Census Report (2017), these dispensaries are available to 40% of the communities, while the hospital in Endulen is available to 12% of the communities in the NCA. The distribution of health services in the NCA is shown in Map 13.

Map 13: Distributon of health servi

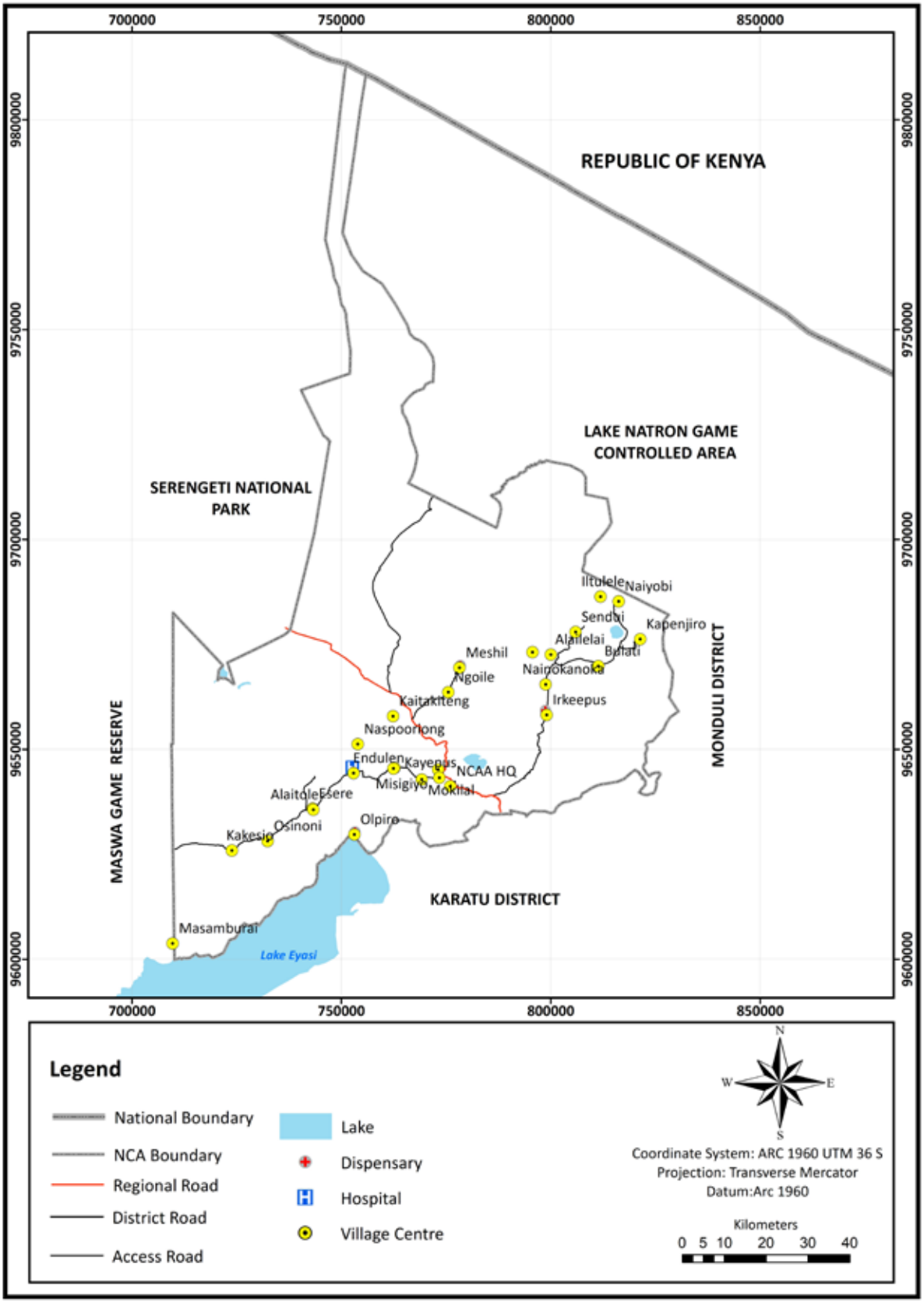


Plate 3: Secton of Endulen Hospital

Sour NCA GMP 2006–2016

3.1.2.3. Roads

The main access route to the Serengeti National Park is through the NCA. In addition, this road leads to Lake Zone regions. There are approximately 500 kilometres of roads and 800 kilometres of tracks and walking trails in the NCA (Table 13 and Map 14). The road network i to users' requirements. These roads serve different functions including administration, anti-poaching, tourism activities and delivering community services. The types of roads in the NCA range from walking trails to main roads, and require sustainable maintenance in order to ensure all year passability.

Table 13: Classes of roads in th

Class	Road Section	Length in Kilometre
Class I	Lodoare to Serengeti boundary (Golini)	86
	Oldupai Museum access	5
Class II	Ngorongoro to Kakesio	76
	View Point to Empakaai Crater (Fosbrooke Road)	78
	Crater main roads (including ascent and descent)	83
Class II Upgrades	Empakaai to Kapenjiro	7
	Empakaai to Naiyobi	11
	Endulen to Olpiro	9

Class III	Crater tracks	100
	Olbalbal from main road	20
	Ndutu from main road	25
	All other tracks and walking trails including a track to Loliondo	800
	Total	1300

Source: NCA GMP 2006–2016

3.1.2.4 Airstrips

There are fve seasonal airstrips (Table 14
Ndutu, Olbalbal, Nasera rock area, Endulen and Ngorongoro.

Table 14: Airstrips in the Ngorongor

Airstrip	Status
Endulen	On black cotton soil and ridge. Dry weather only. 700 m
Ndutu	On sand. 1200 m
Ngorongoro	On edge of Ngorongoro Crater. Unusable June to Sept owing to fog. 1100 m
Olbalbal	On slope. Currently used by fying

Source: NCAA, 2018

3.1.2.5 Communication

Large parts of the NCA have cellular phone
towers located at high points, including t
Kayepus. Other towers are found in Meshil (
Although these may be considered eyesores,
protected area, communicaton towers play a
NCA.

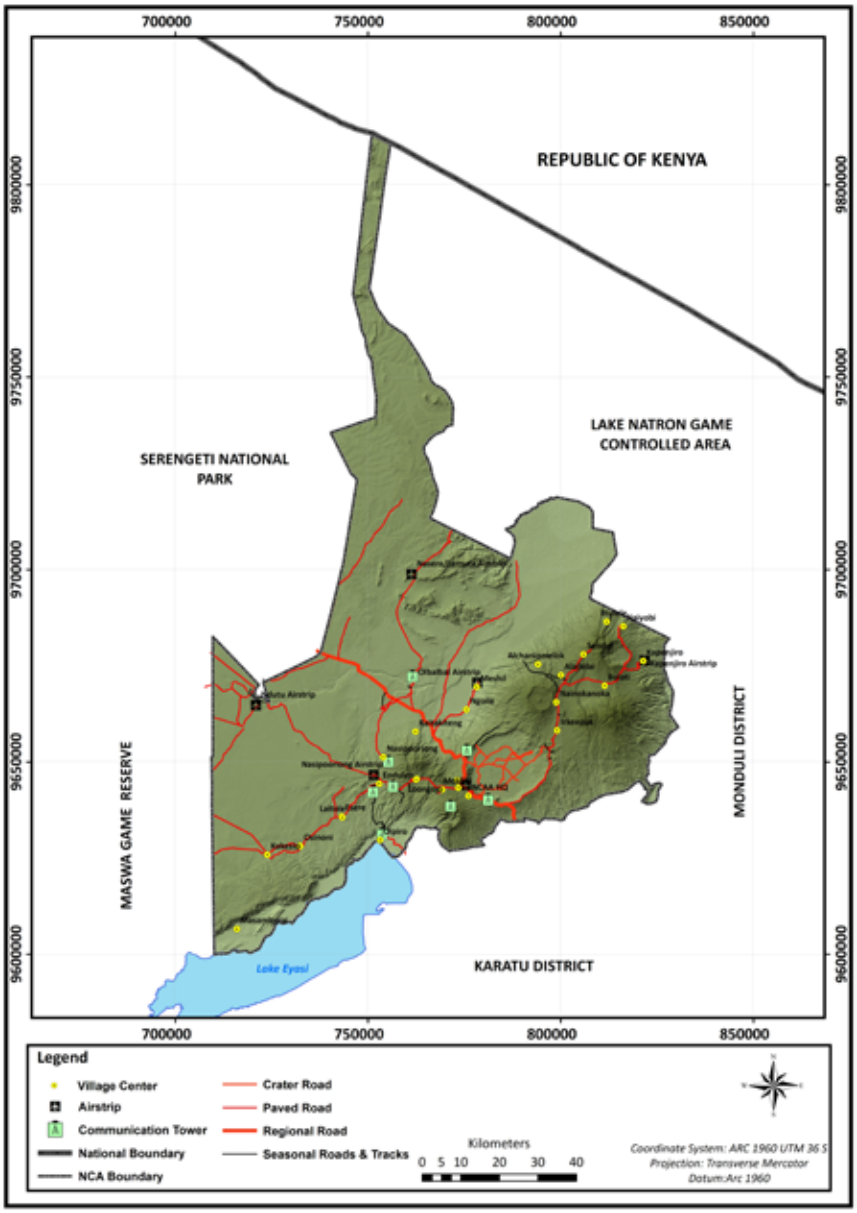
3.1.2.6 Walking Trails

Walking trails have been established in th
of this area and its people. In additon,
partcipate directly in the tourist industr
tours. Toursits' walking trails and stopov

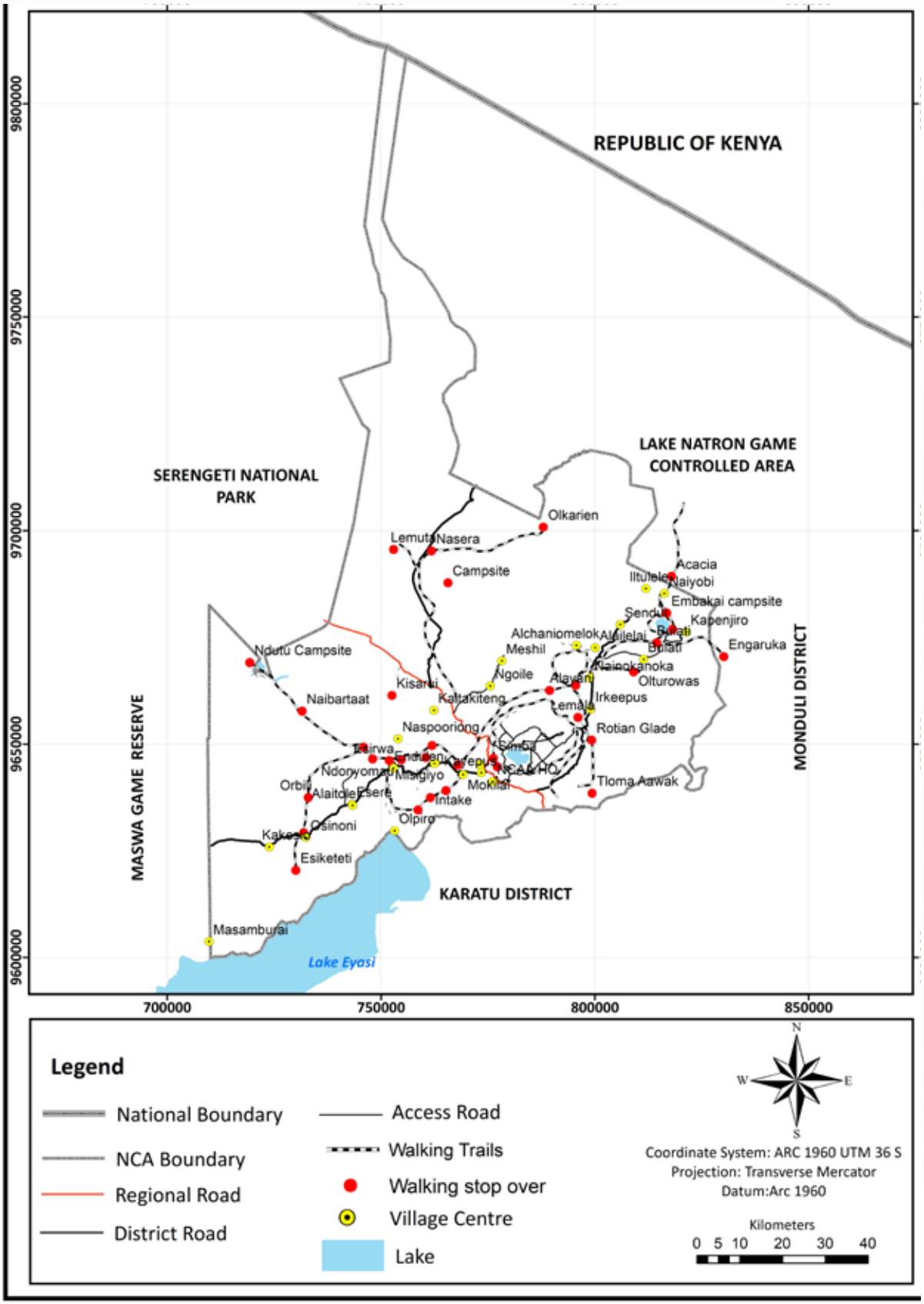
Plate 4: Walking trails in the NCA

Source: NCA GMP 2006–2016

Map 14: Roads and communicaton networks i



Map 15: Toursits walking trails in the



3.1.2.7 Water Supply

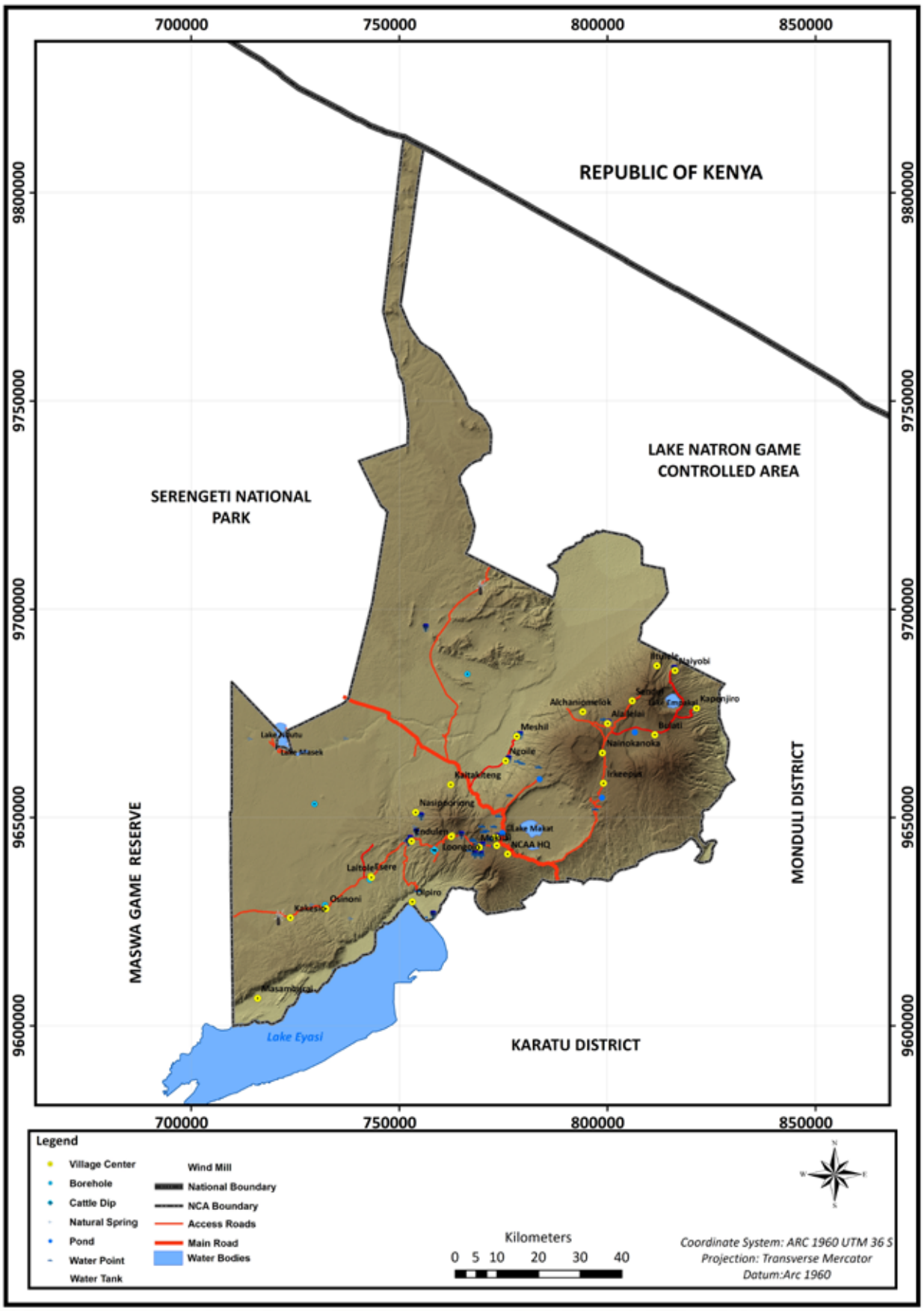
Water supply for communities and their livestock in the NCA is through constructed water points, water tanks, boreholes and charcoal dams. There are fifty-two water points in almost every sett Osinoni, Iltulele and Sendui. Thirty-one water tanks, 15 boreholes and 23 charcoal dams have also been constructed for use in different parts of the NCA. Table 15 below and Map 16 show the distribution and number of water facilities in every settlement in the NCA.

Table 15: Distributon and number of wate

No.	Ward	Village Name	Water Points	Water Tanks	Bore Holes	Charcoal Dams
1.	Olbalbal	Meshil	4	4	3	2
2.	Ngoile	Ngoile	4	2	1	1
3.	Olpiro	Masamburai	-	-	-	-
		Olpiro	1	2	-	-
4.	Ngorongoro	Mokilal	9	5	-	3
		Oloirobi	4	2	-	1
		Kayepus	2	2	-	-
5.	Kakesio	Kakesio	2	1	1	5
		Osinoni	-	-	3	2
6.	Alaitole	Esere	2	2	2	-
		Laitole	2	-	-	2
7.	Endulen	Endulen	3	3	1	-
		Nasipooring	1	1	1	1
8	Misigiyo	Kaitakiteng	1	-	-	1
		Loongojo	2	-	2	-
		Misigiyo	1	1	-	2
9.	Alailelai	Alailelai	2	2	-	-
		Sendui	-	-	1	-
		Alchaniomelok	1	1	-	-
10.	Nainokanoka	Nainokanoka	1	1	-	-
		Irkeepus	2	-	-	1
		Bulat	1	-	-	1
11.	Naiyobi	Naiyobi	1	1	-	-
		Kapenjiro	1	1	-	1
		Iltulele	-	-	-	-
	Total		**52**	**31**	**15**	**23**

Sou: Field Data, 2018

Map 16: Water services distributon

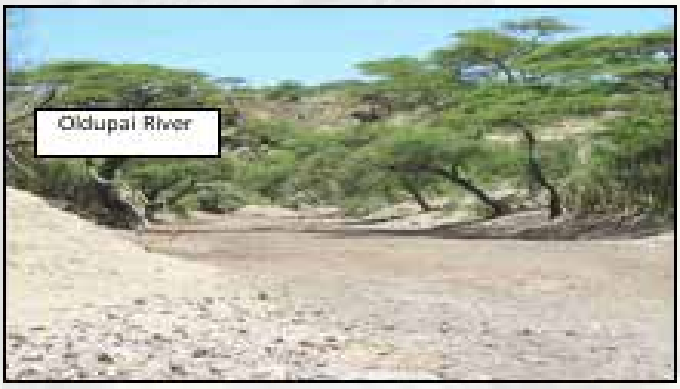


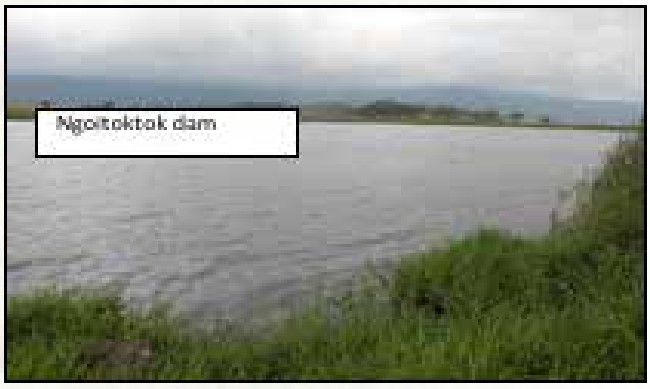
Natural occurring and seasonal water sources such as springs, streams, rivers, lakes, pans and waterholes are also important water sources for communities and their livestock for a few months during the dry season.

Table 16: Natural water sources i

Type	Descripton
Lakes, waterholes	Saha,l pSmasl,l low seasonal lakes or swamps (Malanja) hold water over the early The highly saline lakes of Ndutu a sufciently diluted during the rain Shallow depressions or pans are s area and may hold water anywhere from a few days to a few months. Lake Makat in Ngorongoro C water source.
Springs, streams, rivers	,These are found in four distnct loc south of the Endulen-Kakesio road, Lake Masek and the Gol Mountains. saline. The largest is the Lerai S wall. Apart from rivers in the cra the eastern end of the Endulen-Kakesio area, all watercourses are seasonal. In additon, apart fr spring fed.

Plate 5: Natural water sources in t





Source: Aikman and Cobb, 1997

3.1.2.8 Energy

Most households in the NCA use frewood as cooking. Other sources, although used by fewer households (5%), are electricity, gas, charcoal and animal residuals. Howeve of energy for light in a signifcant numbe Other sources of energy for lighting are touch/rechargeable lamps used by 55% of all households. The NBS Census Report has also shown that about 2% of households in Ngorongoro Division use electricity as the main source of energy for lighting. Other sources include generators and candles, which are used by 1% of households (NBS, 2017).

3.1.2.9 Food Security

Food security status in the NCA considers three factors, which are food consumption, acquisition and shortage. Food consumption and acquisition are determined by the type of food and number of meals consumed per day and how the food consumed is obtained; while food shortage accounts for the number of days on which the household experiences shortage of food as well as availability of food items in Ngorongoro Division. Until 2017, the status of food security differed from one capacity, ownership of livestock and accessibility of food supplied by the NCAA. However, the NBS (2017) found that the majority of households in all 11 wards (about 71%) consumed two meals per day, consisting mostly of milk, meat and legumes. The rest of the population either consumed one, three or four meals per day. Most households with high food consumption per day were found in Ngorongoro and Nainokanoka wards. Communities mostly obtain provisions through buying subsidised food, self-production or assistance by NGOs working in the NCA. In total, 97.6% of households obtained their food through purchase. A signifcant number of households (10,108 food shortage at different times throughout the year.

3.1.3 Socio-Economic Activities

3.1.3.1 Livestock Keeping

Livestock have for long provided economic security, food and a way to live for the Maasai. Maasai are pastoralist livestock keepers who depend on their cattle, goats, sheep and other livestock for their livelihood. According to the NBS Census Report (2017), Ngorngoro Division had a total of 249,069 cattle, 226,263 goats, 348,577 sheep and 22,104 donkeys, with the majority (more than 97%) of these livestock being reared inside the Division. Furthermore, the

census showed that there were 6,497 chickens, 225 pigs, 1,036 cats, 48 camels and 6,220 dogs in the NCA. Ownership of livestock varied from one ward to another depending on the population, availability of pastures and household preferences. Of 20,890 households, in 2017, 71% (16,302 households) owned cattle and 15,733 households (75.4%) owned goats. Nainokanoka, Enduleni, Nayobi and Alailelai wards have the largest number of households owning cattle and goats in the NCA.

The census report also showed that a total of 14,465 households (69.3%) owned sheep, 9,636 households (46.2%) owned donkeys and 4,046 households (19.4%) kept chickens and other livestock (pigs, camels, dogs and cats). Olbalbal, Ngoile and Alailelai wards have the largest number (89.9%) of households that own sheep, with the smallest percentage in Ngorongoro, Eyasi and Endulen wards. Donkeys are mostly kept in Naiyobi, Alailelai and Olbalbal. Eyasi ward has the largest percentage of households that keep chicken and other livestock, followed by Kakesio and Ngorongoro, while Naiyobi, Olbalbal and Nainokanoka wards have the smallest percentage of households which keep chicken and other livestock.

3.1.3.1.1 Livestock Keeping Systems

Pastoral systems, which take many forms adapted to natural, political and economic environments, have evolved to thrive on extensive rangelands in arid or semi-arid climates, of which the NCA pastoralists are inclusive. The types of livestock kept by pastoralists vary according to climate, environment, water and other natural resources and geographical location. These may include cattle, donkeys, camels, goats, sheep, yaks, horses, llamas, alpacas, reindeer and vicunas.

The NCA pastoral communities mostly keep cattle, donkeys, goats and sheep for which extensive grazing is mostly preferred, and livestock keeping is practised by pastoralists. The nomads move from one area to another within and outside the NCA in search of pasture and water for their livestock. The seasonality of rainfall has also made availability of pastures seasonal, hence triggering movements of pastoralists.

3.1.3.1.2 Carrying capacity

Tropical Livestock Unit is a measure used to compare the number and density of livestock grazers to assess the overall effect on grazing land of different types or of mixture of animals, expressed as units per land area. On average, 8.0 (Tropical Livestock Units) TLUs is the

minimum number for a person who solely depends on pastoralism to maintain sustenance. According to the International Livestock Research Institute (ILRI), 1 TLU is equal to 1 cattle weighing 250kg or 10 small stocks. As regards Maasai short horn zebu, body weight is 180kg and small stocks (sheep and goat) weigh 18kg.

Thus, based on the census report of 2017, undertaken by the NBS, the NCA is accommodating about 238,826 cattle *(238,826x0.72= 171,955 TLU)*, 226,260 goats *(226,260x0.072 = 16,291 TLU.),* 344,373 sheep *(344,373x0.072 = 24,795 LU.)* and 22,104 donkeys *(22,104x0.72 = 15,919 LU.)* within its areas of jurisdiction, which in total equals to 228,960 TLUs. The relatively slower growth rate of livestock populations than that of people means TLUs per person have decreased steadily from 11.6 in 1960 to 2.3 in 2017. The carrying capacity for the NCA, which falls within the arid land agro-ecological zone (excluding the northern highlands forest area) with unimo estimated to be on average 14 TLUs/Km^2 (that is between 7 and 20 TLU/Km^2). This is equivalent to 7ha/TLU. Further description of the number of livestock is shown in Table 17.

Table 17: Number of livestock and Tropi

No.	Type of Livestock	Number of Livestock in 2017	Tropical Livesto Units in 2017
1	Cattle (Zebu,	Bor 238,826 &	Ank 171,955)
2	Donkey	22,104	15,919
3	Goat (local)	226,260	16,291
4	Sheep (local)	344,373	24,795
	Total Livestock Number	831,563	/ Uni 228,960
	Per capita TLU in 2017 (ex		2.3 cluding don

Source: NBS, 2017 Census

Therefore, considering the carrying capacity of 7 ha/TLU, a total of 228,960 TLUs will require an area of 228,960 x 7 = 1,602,720 hectares (which is 193.3% of the total land (area) of the NCA). The area zoned for livestock keeping in the GMP 2006–2016 is the same area zoned for sett was about 7,000Km^2 or 700,000 Ha. This area was not enough to accommodate 228,960 TLUs before 2017, in accordance with the carrying capacity of 7 ha/ TLU. Due to such poor carrying capacity, even if the whole of the NCA (8,292 Km^2) were allocated for grazing, it would still not be enough for grazing for the available number of livestock. This implies that the NCA is extremely over stocked and hence immediate measures are required to address the problem.

3.1.3.1.3 Pastures and Water for Livestock

The health status of the rangelands depends much on the quality and quantity of the rangeland resources, and largely on the season. Rangelands are grazing-dependent systems. Therefore, livestock production in dry land areas depends mainly on natural pastures fuctuating with of pastures decreases during dry season and improves during wet seasons. Similarly, the grass and leguminous species are affected by drought and overgrazing.

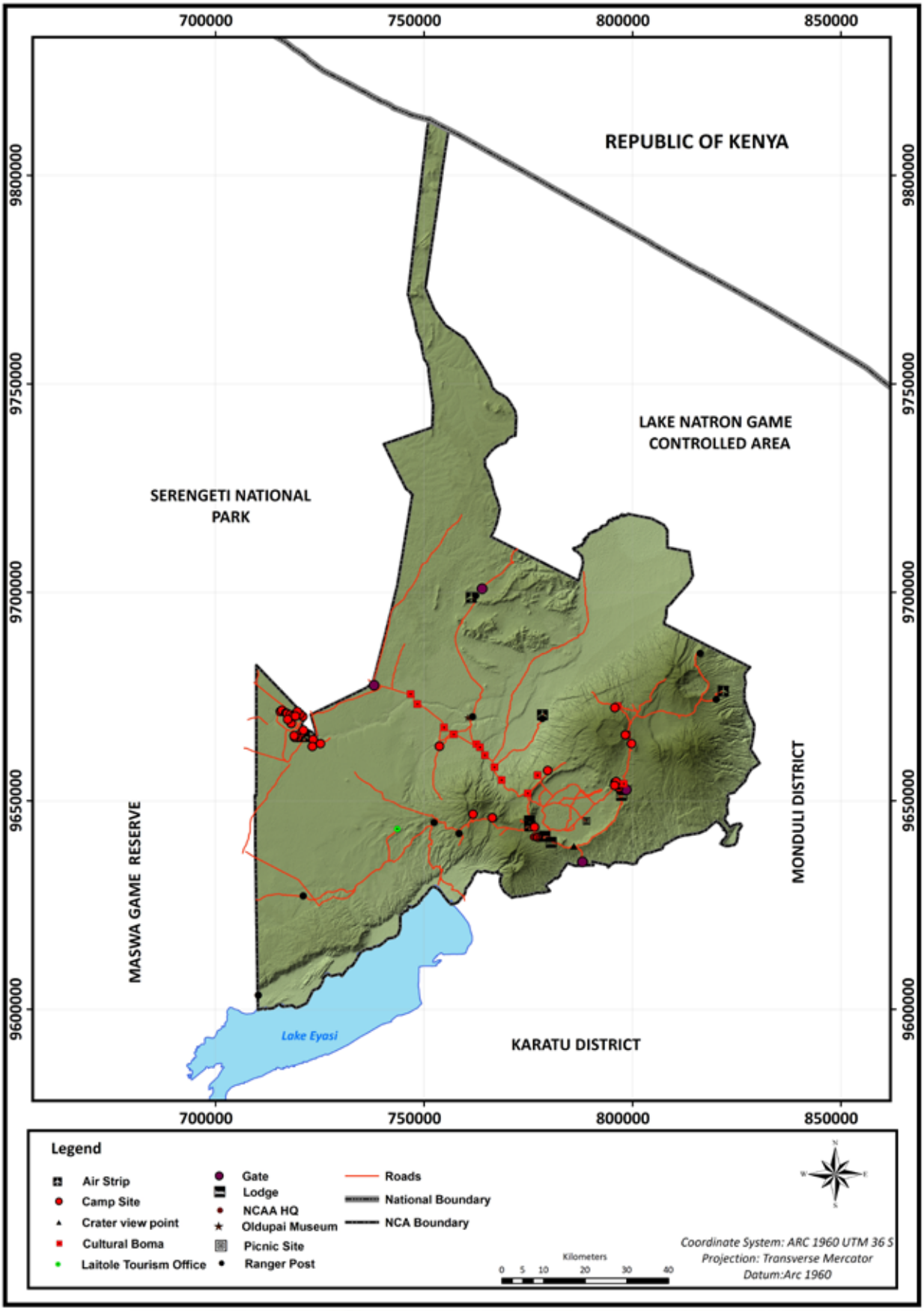
Although most of the semi-arid and arid rangelands of Tanzania are charcterised by grasslands vegetation, dense thickets, grasslands, the Northern Tanzania semi-arid rangelands including the NCA have a lower density and fewer species of trees to a lesser extent, in some areas of the NCA there is availability of animal plant foods during the dry season especially the Acacia seeds/pods, *Adansonia digitata* leaves and fowers, grass seeds and th plants. The onset and duration of rainfall in these semi-arid areas are inherently stochastic, water scarcity is a common phenomenon and the probability of the occurrence of acute drought is high.

3.1.3.1.4 Tourism

Apart from livestock keeping, communities in the NCA engage in different tourism-based activities that enable them to earn income. These activities are, for example, selling tourist goods (which involves the largest proportion of households), entertaining tourists including traditional dances, tour guiding and translation as well as provision of security services (employment) in lodges. A proportion of households in the NCA is also involved in carrying luggage (porting), operation of cultural bomas and photographic activities.

The importance of tourism varies from one ward to another with Nainokanoka, Endulen, Ngorongoro and Ngoile having the largest number of households whose members are engaging in at least one of the tourism-based activities (NBS, 2017). Cultural bomas in the NCA are providing the indigenous especially women with an opportunity to sell traditional goods. Currently, there are 14 cultural bomas located in Meshil, Ngoile, Oloirobi, Kayepus, Naspooriong, Kaitakiteng, Loongojok, Misigiyo, Alchaniomelok, Nainokanoka and Irkeepus. Major existing tourism services are lodges and campsites. Existing lodges are Sopa lodge, Serena lodge, Ngorongoro Wildlife lodge, Masek lodge, Ndutu lodge, TNS hospitality lodge and Tawisa tented camp. Many campsites are located in Ndutu area, while some are located in the Northern Highlands Forest Reserve and other parts of the NCA.

Map 17: Existng tourism facilite



3.1.3.1.5 Beekeeping

Beekeeping in Tanzania plays a major role in socio-economic development and environmental conservation. It is a source of food (e.g., honey, pollen and brood), raw materials for various industries (e.g., beeswax candles, lubricants), medicine (honey, propolis, beeswax bee venom) and a source of income for beekeepers. It is estimated that the sector generates about US$ 1.7 million each year from sales of honey and beeswax and employs about 2 million rural people. It is an important income generating activity with high potential for improving incomes, especially for communities living close to forests and woodlands. The NCA with its natural forests and woodlands provides an opportunity for beekeeping to people whose local economy is limited to conservation friendly activities.

Currently, beekeeping in the NCA is undertaken mostly by some members of the community living in Osinoni, Kakesio, Olpiro, Aleilelai and Kapenjiro settlements. However, beekeeping activities are still undertaken in an unsustainable manner using traditional methods by the majority of households. Communities mostly use traditional hives including log and bark hives as well as reeds, gourds and pots. Unsustainable beekeeping and harvesting has also led to numerous cases of wildfres in these areas. In recent yea small groups of beekeepers within and adjacent to the conservation area. The focus particularly is on education of better beekeeping by providing modern beehives (Plate 6) and other equipment for honey harvest. Further community support by the NCAA is needed to ensure that these activities are undertaken in a sustainable manner, which enables the community to market, sell and earn more income from their livelihood.

Plate 6: Beekeeping in the NCA using m

Sour GMP 2006–2016

3.2 Bio-Physical Conditions

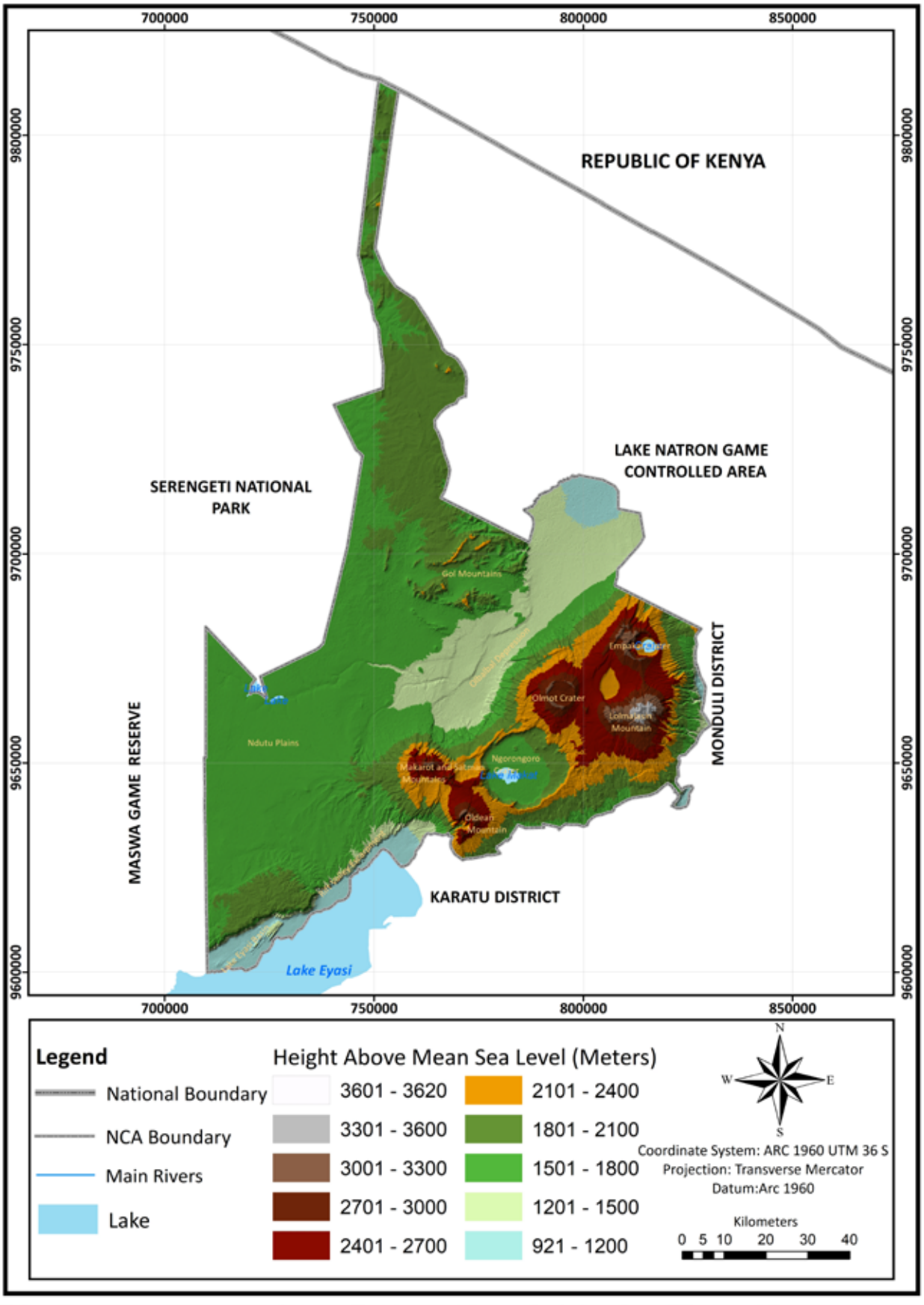
3.2.1 Topography

The NCA has one of the most diverse landscapes in East Africa. Ranging from arid lowlands to mountain peaks, with a vertical difference of approximately 2500 metres, the landscape provides a spectacular backdrop to the wildlife of the area. The crater highlands are the dominant topographic feature of the area. These cover approximately 3200 km^2 and almost all of it lies within the NCA. Other important topographic features are the Gol Mountains, an ancient granitic intrusion into the sea of volcanic rock, which covers the area. Several escarpments can be seen, the most famous being the western wall of the Gregory rift which runs along the eastern boundary of the NCA. Other notable escarpments are the Eyasi escarpment in the south and the walls bounding the Ang'ata Salei. Within the crater highlands, there are a number of extinct volcanoes. Some of these, such as the Ngorongoro and Empakaai, have collapsed to form impressive calderas. Others, such as Satiman, Loolmalasin and Makarot, are still incomplete. Loolmalasin is the third highest mountain in Tanzania after Kilimanjaro and Meru. Landforms and topography of the NCA are shown in Plate 7 and Map 18 respectively.

Plate 7: Landforms of the Ngorongoro Co

Source: GMP: 2006 – 2016

Map 18: Topography of the Ngorongoro



3.2.2 Geology

Most of the NCA is overlain by volcanic deposits. The Gol Mountains are granitic in origin and pre-date the volcanic rocks. Parts of the outliers of these hills are composed of banded ironstone. Lacustrine deposits are found around Lakes Eyasi and Manyara. To the north of Lake Eyasi, within the NCA, are further exposures of granitic-derived material and these form most of the escarpment found above the lake. According to Pickering (1993), the NCA is composed of three main types of rock, which are ancient crystalline rocks, lavas and ashes. Brief descriptions of these rocks are presented in Table 18.

Table 18: Rocks of the NCA

Rock Type	Brief Descripton
Crystalline Rocks	Found along the Eyasi scarp and th were formed deep in the earth's c quartzites, gneisses, granite and crushed rocks. The quartzites are hard, resistant rocks and fou Gol Mountains. Gneisses occur alo common in the Gol Mountains.
Lavas	Early lavas were food basalts, w fows, and ash deposits from "clas
Ashes	Superfcial deposits on the presen ashes and tufs, screes, sands, gr and sands, muds, limestones and s

Source: Pickering, 1993

3.2.3 Soils

The topography and soils of the Serengeti ecosystem are comprehensively covered in the Serengeti-Masai Mara trans-boundary protection and monitoring plan (EAC, 2012). The basement complex of the ecosystem is made of pre-Cambrian igneous and metamorphic rocks. Erosion and volcanic activities have changed the surface of this ecosystem to the present topographic forms characterised by extensive plains, escarpments and valleys. The rangelands and escarpments are characterised by rich volcanic soils, while poorly drained brown soils occur in the plateaus and plains where extensive grasslands are common. River basins and valleys have clay soils enriched with accumulated sediments (EAC, 2012).

Therefore, soils in the NCA are derived from the underlying parent rocks and almost all the soils found in the area are basaltic in origin. Different soil types in

the NCA and their geological classifcation shown in Table 19 and Map 19.

Table 19: Soil types for different areas i

Area	Geology	Soil Type
Dense forests	Alkaline volcanics (basalts and phonolites)	Volcanic soils dominated by eutric leptosols and haplic s
Short grass	Granite and alkaline volcanics (basalts and	Volcanic soils dominated by cambic arenosols, chernozems and rendzic leptosols
Bushlands and woodlands	Alkaline volcanic rocks (basalts and marble quartz schists and chlorites	Volcanic soils dominated by eutric leptosols, luv phaeozems and gleyic
Highland grasslands	Alkaline volcanic rocks (basalts and	Volcanic dominated by eutric leptosols and dystric ph
Dense bushes (thickets)	Lacustrine (alluvial and granite (archean)	Silt and gravel, hapli leptosols and chernoze
Swamps and	Alkaline rocks	Saline soils dominated by sandy and clayey
Depressions	Alkaline volcanics (basalts and phonolites)	Volcanic soils dominated by eutric leptosols

Material deposited from Lengai eruptions has formed a series of dunes to the west of the volcano. The low rainfall in the area meant that plant growth to stabilise the dunes was slow and, consequently, many shifted long distances before stabilising. Several are still moving, the most famous “shifting sand” is seen in the north of the Oldupai Gorge and is moving at approximately 17 metres per annum.

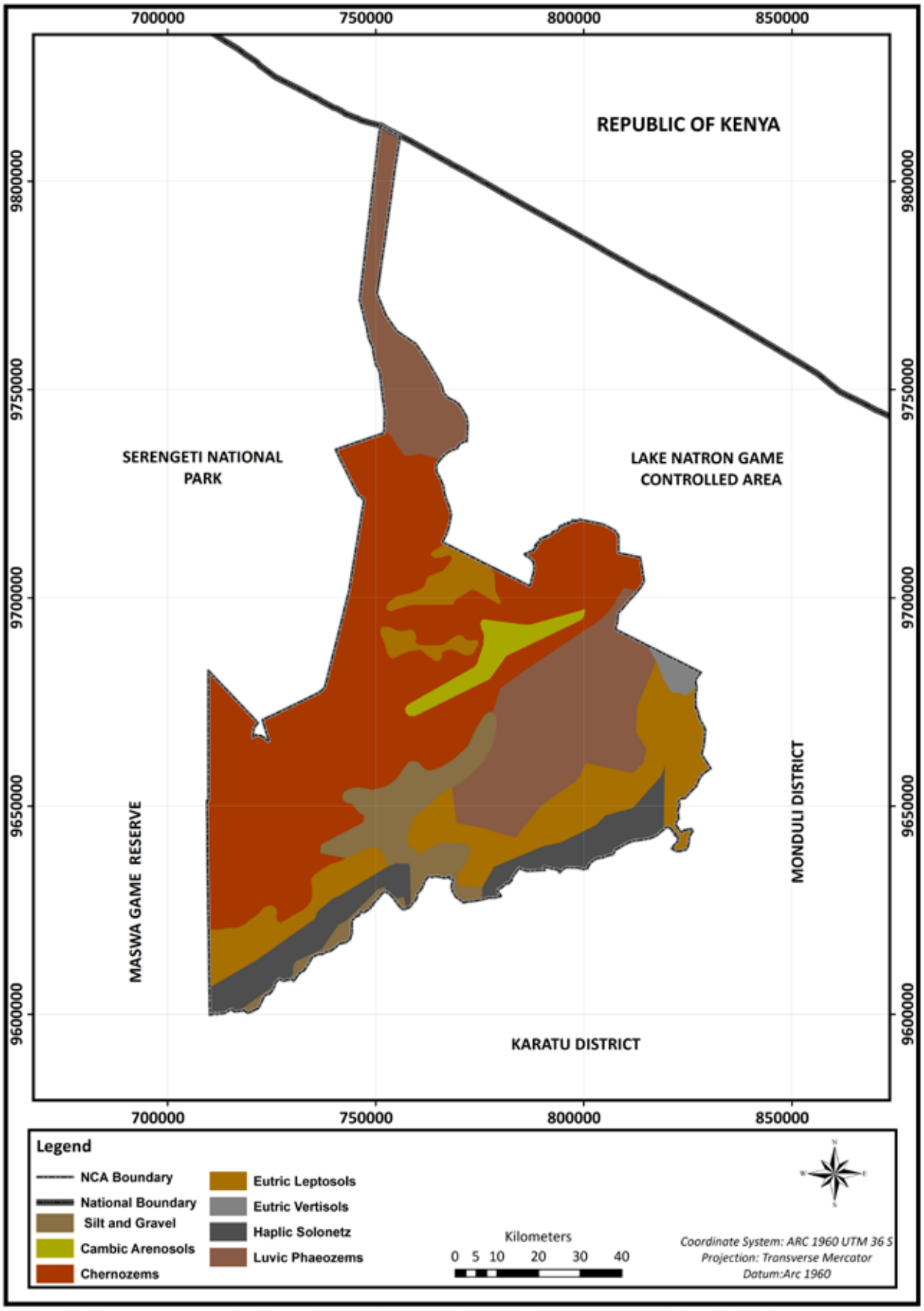
3.2.4 Drainage

Much of the drainage pattern in the NCA is of small internal streams, either into crater lakes, such as the Munge River fowi or into depressions such as Olbalbal, which may hold water for up to 10 months of a wet year (Map 20). Generally, the NCA has four internal drainage basins (Olbalbal, Ngorongoro Crater, Empakai Crater and Malanja) and six external drainage systems (Table 20). All these external streams drain into saline, land-locked drainage basins (Lakes Eyasi, Manyara and Natron).

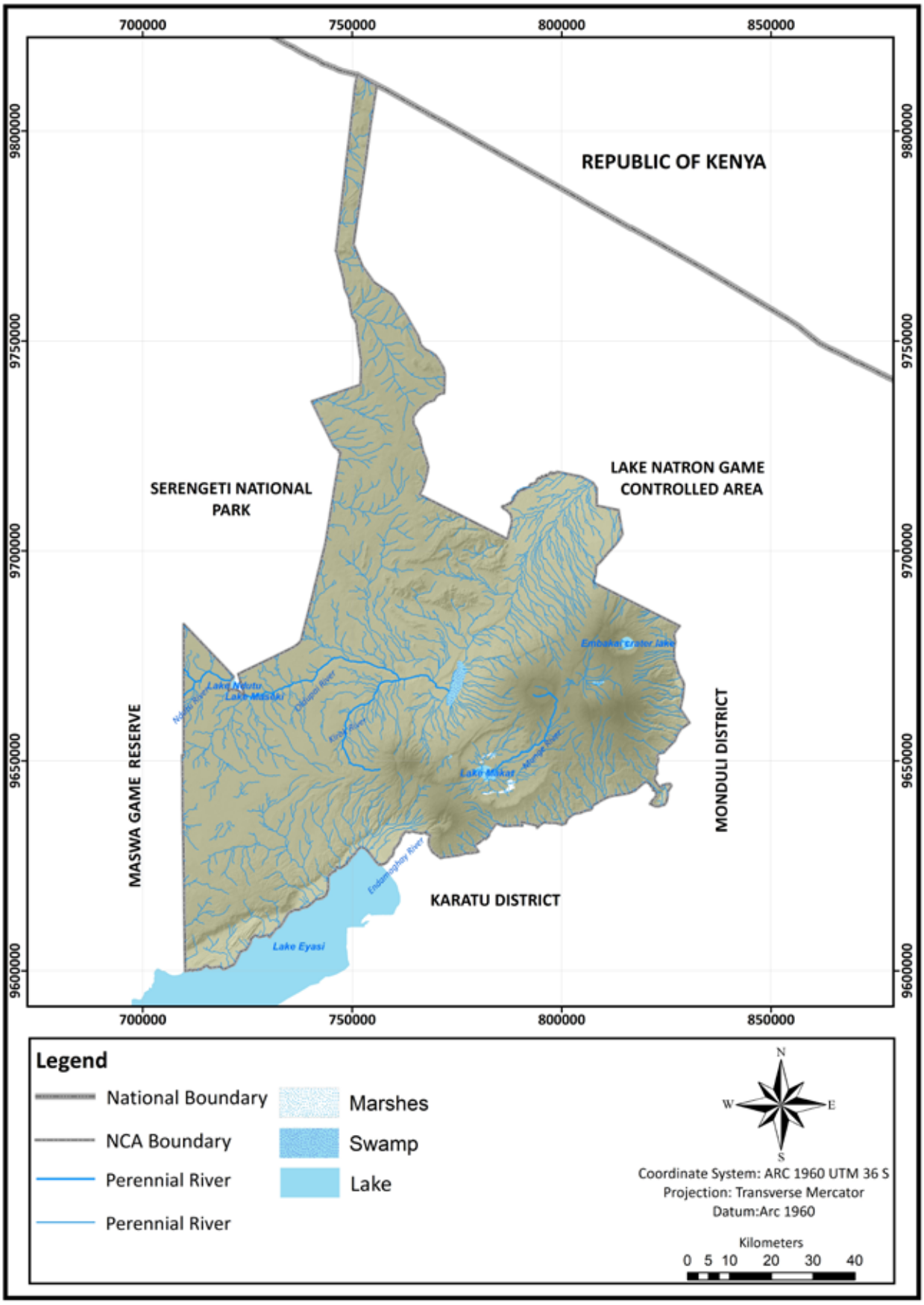
Table 20: Drainage basins of the

Basin	Size (km^2)	Comments
Completely Internal		
Ngorongoro	503	Drains part of the highlands a Lake Makat
Embulbul	200	Internal drainage basin of the NCA. Seasonal water in the low-lying areas
Empakaai	40	Small internal basin feeding t
Malanja	35	Small internal basin with a se
External		
Olbalbal	2 993	Internal drainage basin into Waters from Ndutu and Masek l down the Oldupai River
Natron	1 453	A shallow, highly saline endo Most water enters from Kenya, important source
Manyara	373	Saline lake with variable sur Manyara NP. Maximum depth of 3
Nile	315	About 4% of the NCA draining into Lake Victoria. Only basin (Mediterranean)
Engaruka	313	-
Ulmkuku	84	-

Map 19: Soil types of the NCA



Map 20: Drainage patern of the N



3.2.5 Vegetation

The NCA vegetaton is variable and shaped b
is weter in the eastern highlands and this
The lower ground in the west and south a
bushland and open Several studies have been carried out
the vegetaton and the following descriptor
their summaries.

Table 3.2.1 Broad vegetaton types of the N

Vegetation Type	Description
Forest	These are restricted to the weter e way to scrubland when the rainfall broadly as undiferentated montane and as dry transitonal montane for may be one of the largest examples Africa.
Highland shrub and grassland	In general, the highland grasslands are dominated by tussock grasses with variable shrub-herb content. The grassland at higher altudes (above 2,000 m) is over dominate *Festuca jaegeri*. At lower levels, *Pennisetum sphacelatum* is more common. The Embulbul depression has a short grass plain area.
Bushland and woodland	The climax woodland in the NCA is *Acacia* and *Commiphora* species. Several communites • *Acacia lahai* stands are found on the moi • *Acacia xanthophlea* stands are found in areas where the ground water level is high (e.g., Lerai • *Acacia drepanolobium* are found on the medium ○ Acacia tortilis stands (with other Acacia in the area near Lake Ndutu ○ *Acacia mellifera-Commiphora* stands are found in the drier areas near Oldupai ○ The slopes of the Gol Mountains wooded grassland with emergent trees
Plains grassland	The fat-topped hills and grassy p tuf soils have typical short-grass increases, the short grass gives wa of the Serenget.

Source: Homewood and Rodgers, 1991

Table 22: Main species of forest

Forest		
Canopy	Undergrowth	Variants
Undiferentated Montane Forest		
Bersama abyssinica *Cassipourea malosana* *Ekebergia capensis* *Hagenia abyssinica* *Nuxia congesta* *Olea capensis* *Olea europea* *Podocarpus*	Abutilon mgicuspa *Crolalaria arborea* *Discopodium panninervium* *Urlica massaiense* *Vernonia auriculifera*	*Juniperus procera* (on Makarot and Loolmal *Arundinaria alpina* bamboo on Oldeani
Dry Transitonal Montane Forest		
Albizia gummifera *Croton macrostachys* *Croton megalocarpus* *Fagaropsis africana* *Ficus thonningii* *Teclea nobilis*	Varied (many species)	Rubeinaceae), patch shrubland
Afromontane Evergreen Thicket		
	Buddleia polystachya *Juniperus pro cera* at > 2500 m Cluatbaysinica *Heteromorpha trifoliata* *Osyris lanceolata* *Rhus natalensis* *Rumex usambarensis* Scumtyartna	*Juniperus procera* >2500 m

Source: Homewood and Rodgers, 1991

Table 23: Main species of montane grassland

Montane Grassland and Shrubland		
Tussock species	Turf / Mat Species	Shrub / Herb species
Grassland		
Eleusine jaegeri *Pennisetum sphacelatum* (= *P. schimperi*) *Streblochaete longarista* *Themeda triandra*	*Andropogon greenwayi* *Cynodon dactylon* *Digitaria abyssiniea* (= *D. scalarum*) Pennisetum mezianum	Artemisia afra *Helichrysum schimperi* *Lupinus princei* *Salvia merjamie* *Satureja punctata* *Senecio* spp. *Trifolium massaiense*

Shrubland		
Pennisetum sphacelatum Themeda triandra	*Andropogon greenwayi* *Cynodon dactylon* *Digitaria abyssiniea (D. scalarum)* *Pennisetum stramineum*	*Erica arborea* *Lantana camara* *Lippia javanica* *Stoebe kilimandscharica*

Source: Homewood and Rodgers, 1991

Table 24 species of bushland and wo

Bushland and Woodland		
Tree	Herb	**Grass**
Acacia lahai		
Acacia lahai *Gnidia glauca*	*Erlangea tomentosa* *Hypericum revolutum* *Leonotis nepetifolia*	*Cynodon dactylon* *Pennisetum stramineum* *Digitaria abyssinica*
Acacia drepanolobium		
Acacia drepanolobium *Acacia hockii*	*Crotalaria spp.* *Indigofera bogdani*	*Themeda triandra*
Gol slopes		
Acacia clavata *Acacia lahai* *Erythrina abyssinica* *Commiphora trothae* *Commiphora subsessifolia* *Euphorbia nyikae*	*Rhynchosia minima* *Aspilia mossambicensis* *Malvaceae spp.*	*Digitaria macroblephara* *Themeda triandra* *Aristida adoensis*
Ilmesigio (Misigiyo) lower slopes		
Acacia drepanolobium *Albizia anthelmintica* *Grewia bicolor* *Rhus vulgaris*	Varied	*Hyparrhenia spp.* *Themeda triandra*

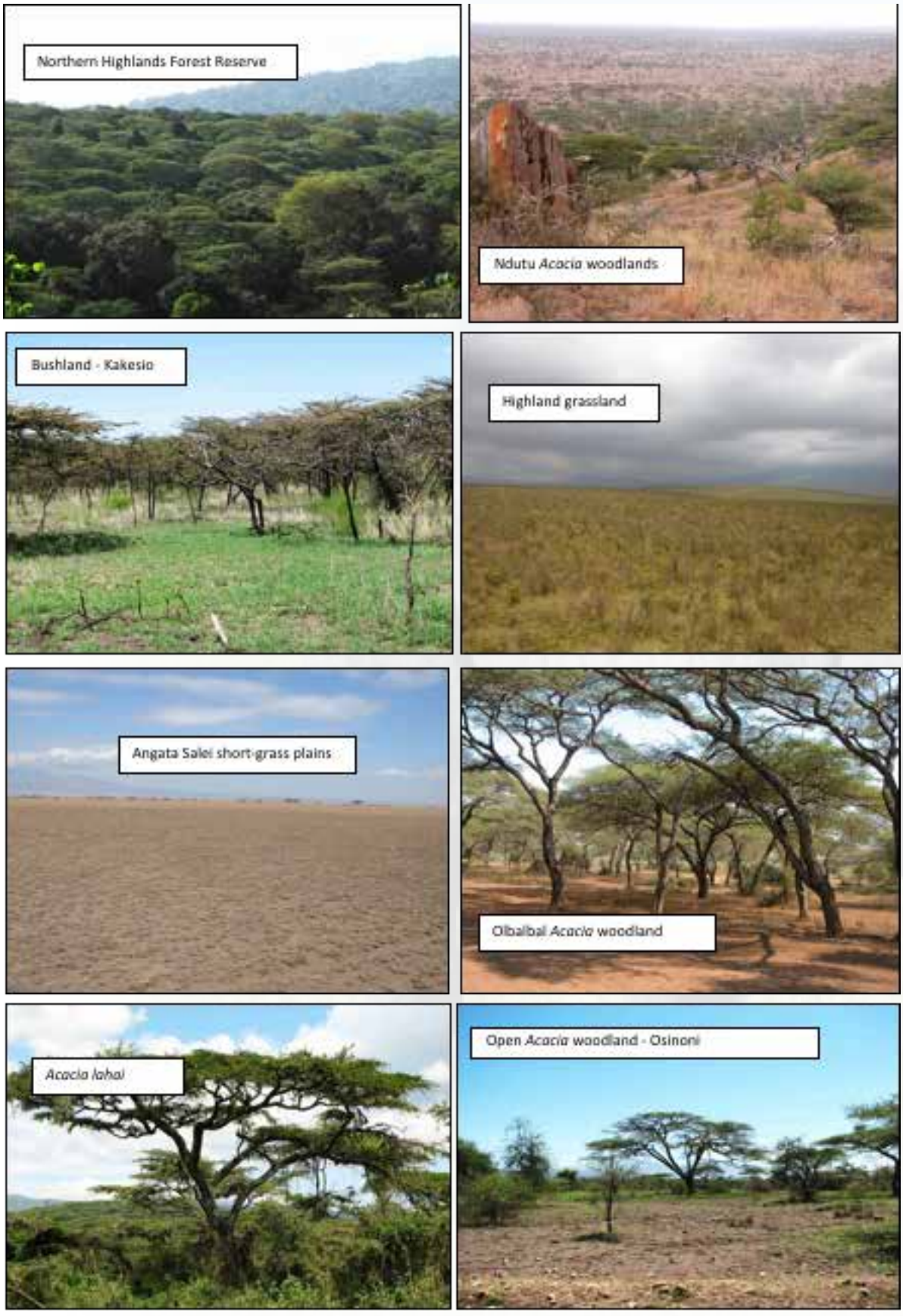
Source: Homewood and Rodgers, 1991

Table 25 species of plains grassl

PLAINS GRASSLAND		
Grasses / Sedges	Herbs	Variants
Aristida adoensis *Cynodon dactylon* *Chloris virgata* *Digitaria abyssinica* *Harpachne schimperi* *Sporobolus ioclados* *Kyllinga spp.*	*Crotalaria keniensis* *Euphorbia inaequilaterale* *Indigofera bogdani* *Hirpicium echinus* *Solanum incanum*	*Hypoestes forskalii* along drainage lines

Source: Homewood and Rodgers, 1991

Plate 8: Vegetaton types in the NC



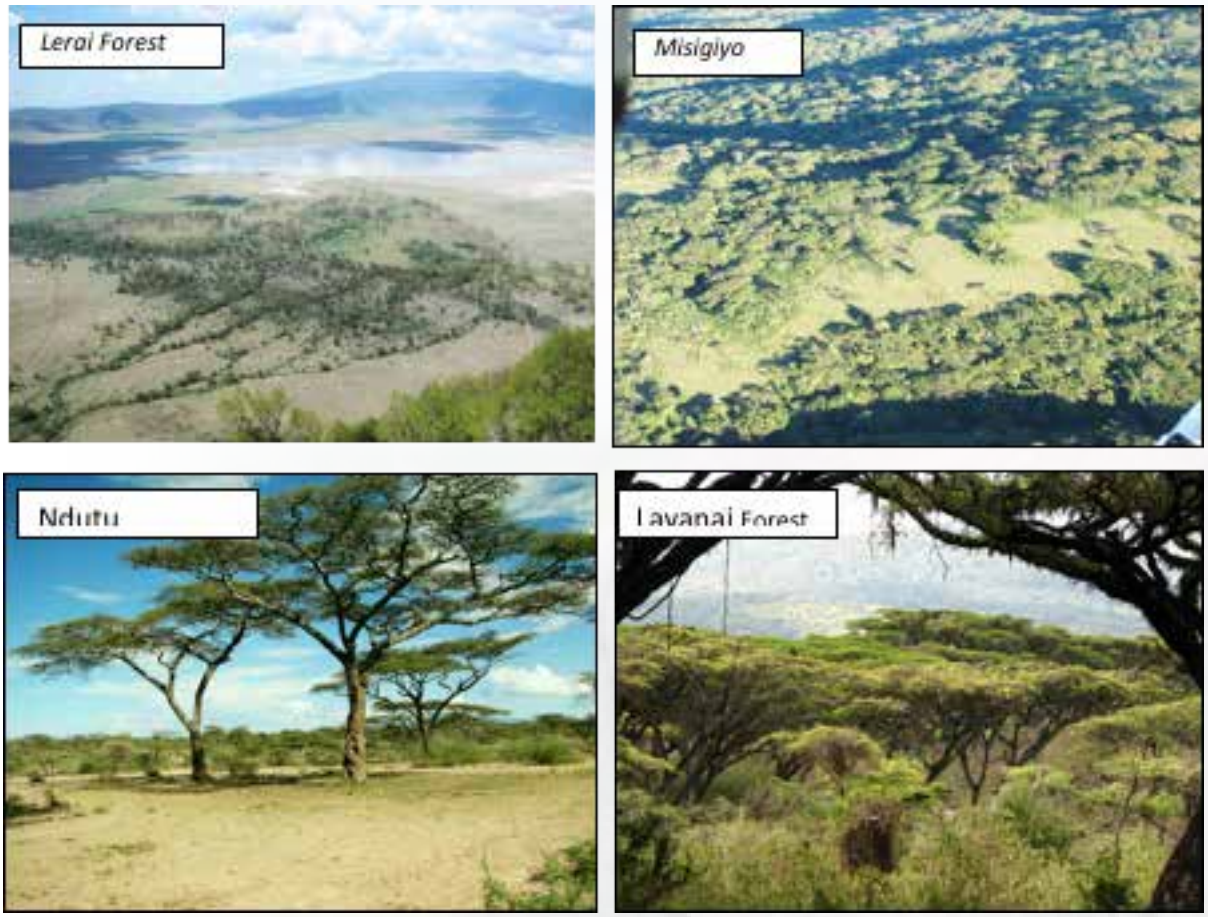
Source: GMP 2006–2016

Outside of the closed forest of the Northern Highland Forest Reserve, there are several noteworthy forests and woodlands mostly composed of *Acacia* species (*A. lahai, A. xanthophlea* and *A. tortillis*). These are found at Layanai, Msigiyo, ELerai, Ngoitoktok and Ndutu. A brief description of these forests is given in Table 26.

Table 26: *Acacia* forests and woodlands in

Forest	Description
Layanai	Dense forest along eastern rim area o mainly of *Acacia lahai.* Used by residents of Irkeep areas, where there is open ground, ar
Msigiyo	Main *Acacia lahai* forest scatered on the weste mountain. At alttudes above 2500m Jun concentrated in the drainage lines. T that the area is important for grazi fuelwood.
ELerai	Groundwater *Acacia xanthophlea* forest on crater foor. 5 km². Wildlife refuge and important tou site with fush toilets. The forest ha last 50 years with most die-back in t on the terraces and higher ground to the west and south. The forest is thought to be partcularly important t
Ngoitoktok	Another *Acacia xanthophlea* groundwater forest fed by Ngiotoktok and Soitnaudo springs. This forest was re had thinned out by the 1970s (Fosbro seems to have recovered.
Ndutu	Acacia woodland. Extensive woodlands n

Plate 9: Noteworthy forests in the



Source: GMP: 2006 – 2016

3.2.6 Wildlife

a) Animals

The NCA is world famous for its wildlife this are the Ngorongoro Crater itself and and gazelle into the northern plains. Outs populatons are low, but generally highly v

b) Birds

Close to 600 different bird species have been recorded from the NCA (Table 19). The area's diversity of habitats makes this an important bird habitat. The variety of wetland types within the NCA is remarkable and many unusual species can be found here. The alkaline lakes are important for the Greater and Lesser Flamingoes. The temporary wetlands in the Malanja and Olbalbal depressions are important breeding sites for a number of species. As they are temporary, they do not harbour predators such as monitor lizards, which allow the birds to breed in relative safety. The Serengeti ecosystem has more than 30% of the

world's population of Ruppell's vulture. Ilkarian Gorge (Plate 10) and other sites in the Gol Mountains are important nesting sites in the NCA.

Plate 10: Olkarien Gorge – nestng site

Source: GMP 2006–2016

The NCA can be divided into fve main wild
Rodgers, 1991; Table 18). These birds are highly dependent on altitude and
habitat and the main types are briefy desc

Table 27: Wildlife communites in

Area	Main Characteristcs
Forest (Oldean NHFR)	Tihe anNdCA forest fauna is relatvely small mammals and birds, but is herbivores.
Arid Areas (South Natron and Eyasi)	The area surrounding Lake Natron populatons of wildebeest and zeb Grant's gazelle, oryx and lesser bushlands stll support small num these are subject to poaching pr
Ngorongoro Crater Populatons	The crater holds most dry season the NCA (apart from giraf e, elan occur seasonally (e.g. wildebees longer term (e.g. bufalo). The l density and appears remarkably s wild-dog and cheetah are only pr

Highland Grassland	The highland grasslands include a resident in the Olmot and Empaka from the Ngorongoro Crater and t common and eland, reedbuck and steinbuck are frequently seen. Wildebeest and gazelles are more common in the Malanja area and on the western grass plains.
Northern Grasslands (Gol, Ndutu etc.)	Largely devoid of wildlife in the dry season, the northern plains are invaded by migratng a between December and March/April million animals (mainly wildebee gazelles and their atendant preda

Source: Homewood and Rodgers, 1991

Table 28: Bird species associatons

Area	Notes
Highland Forest	Important birds of prey include t Mountain Buzzard and Crowned Eagles Turaco and the Bar-Tailed Trogon can also be seen in the forest. The Brown-Backed Woodpecker is a ra sunbirds, robins and fycatchers liv
High Altitude Grassland	A unique endemic race of the Alpine Chat Other notable species are the Scarl the Streaky Seed-eater, the Northern Anteater Chat and Jackson's Widowbird.
Ngorongoro Crater	A wide variety of habitats allows f Kori Bustards and Secretary birds the tme of year. The Cape Rook (rar found here. Many open country rapto thermals.
Oldupai	The area is the western limit for country species such as White-bell Eye, Grey Wren Warbler, Taita Fiscal and Eastern Backed Sunbird are locally common.
Ndutu	Includes three Tanzanian endemics Tailed Weaver and Grey-Breasted Spu abundance of cuckoos. Larks, warb eromelas and weavers are easily seen.

Source: Baker and Baker, 2001

3.2.7 Cultural Heritage Resources within NCA Boundaries

3.2.7.1 Alaitole Footprints

The Alaetoli footprints are the oldest known footprints of early ancestors of humans in the world. The site of Laetoli is 25 miles to the southwest of Olduvai Gorge in the Conservation Area. The fossil deposits at Alaitole span a period of several million years, with the lowest units dated to 3,800,000 years ago and the upper unit to about 120,000 years ago. About 3.6 million years ago in Laetoli, two early ancestors of humans walked through wet volcanic ash. When the nearby volcano erupted again, subsequent layers of ash covered and preserved the oldest footprints of early humans.

Plate 11: The Alaitole site

Source: GMP 2006–2016

According to archaeologists, the Laetoli Footprints present three separate tracks of an upright walking hominid named *Australopithecus afarensis*. The entire footprint trail is almost 27 metres long and includes impressions of about 70 early human footprints. Replicas of these footprints are displayed at Olduvai Museum. The Laetoli area was first studied by Larsen in the 1920s, and yielded a few fossils. In 1974, a team led by Mary Leakey made the discoveries of the hominid footprints, and excavations were carried out in 1978 and 1979.

Deposits at Laetoli are divided into five m
order:

- Ngaloba Beds 700,000 – 120,000 years ago

- Olpiro Beds 1,200,000 – 700,000 years ago
- Naibartat Beds 2,000,000 – 1,200,000 years
- Ndolanya Beds 3,500,000 – 2,400,000 years
- Alaitole Beds 3,800,000 – 3,500,000 years

Thirteen localities have been surveyed and have revealed the following:

- 13 hominid fossils with the majority dat ago
- Vertebrate faunal remains from 80 species
- Invertebrate fossils
- Floral remains from 80 taxa
- A profusion of animal prints and trails
- Stone artefacts

The Alaitole footprints are signifcant for the earliest preserved direct traces of our ancestors and, secondly, they are the earliest evidence of bipedalism in hominids. These tracks are probably deposited in the ash from the Satiman eruptions. After excavation, the hominid trackway and all other prints (animals and birds) were buried. However, this initial burial was inadequate, and a second "permanent" burial was needed, after detailed records were made. The investigation, cleaning of the site and reburial took four years to complete. Today, the site is off-limits to tourists.

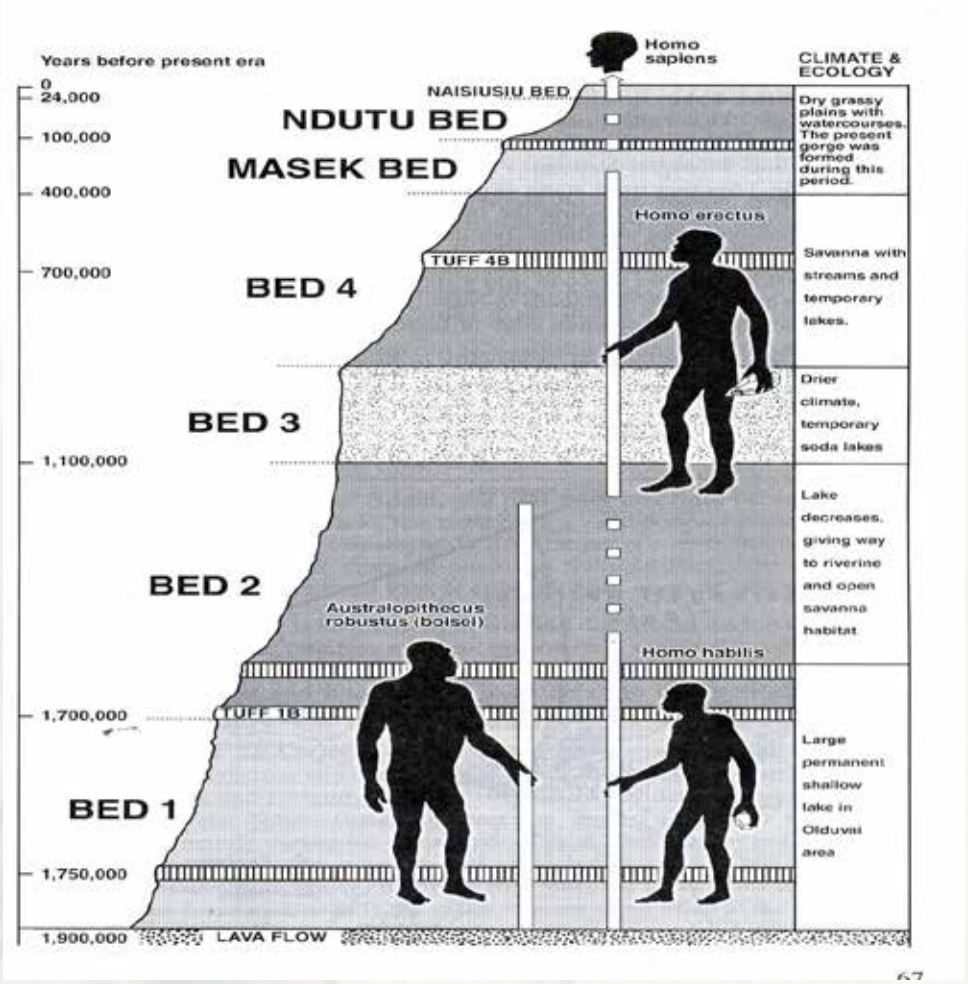
3.2.7.2 Oldupai Gorge

The Oldupai deposits are divided into seven different beds:

- Naisiusu Beds 20,000 – 10,000 years ago
- Ndutu Beds 300,000 – 60,000 years ago
- Masek Beds 400,000 – 300,000 years ago
- Bed IV 700,000 – 600,000 years ago
- Bed HI 1,000,000 – 700,000 years ago
- Bed II 1,500,000 – 1,000,000 years ago
- Basalt 2,000,000 + years ago

Approximately 50 localities with concentrated patches of artefacts and faunal materials have been identifed and docume archaeological sites. Despite the systematic surveys undertaken, it is clear that many materials and concentrated patches of artefacts and faunal remains are still buried in the Oldupai deposits. The hominid remains from Oldupai (and other localities in the NCA) make it one of the most important and continuous assemblages of these artefacts in the world. A visual representation of hominid history in relation to the Oldupai beds is shown in Plate 12 below.

Plate 12: Human history as evidenced by



Source: GMP: 2006 – 2016

More than 60 hominid remains representing two genera and three species have been found in the gorge. While some of these represent the earliest remains found, the continuous temporal record of remains is also important. In addition to the hominid remains, the area also provides vertebrate and invertebrate fauna representing more than 150 taxa, stone tool assemblages dating from very early manufacture to the later Stone Age and palaeo-environmental data.

At the edge of Olduvai Gorge, there is a small museum, the Olduvai Gorge Museum, which exhibits numerous fossils and stone tools of our hominid ancestors, and skeletons of many extinct animals excavated in the gorge. The museum was founded by Mary Leakey and it is dedicated to the appreciation and understanding of the Olduvai Gorge and Laetoli fossil sites. Apart from shops, offces, visitor facilities and exh outdoor lecture areas where the museum curators give orientation presentations to visitors. At the museum, one can also plan a guided tour down the gorge. The Cultural Heritage Division of the NCAA runs the Oldupai Gorge Museum. All visitors to the site are required to pay an entry fee that is determined periodically by the Cultural Heritage Division of Authority.

Plate 13: The Oldupai beds

Source: NCAA, 2019

Plate 14: The Oldupai Gorge Museum

Source: NCAA, 2019

3.2.7.3 Olkarien Gorge

The Olkarien Gorge (also written Ol Karien or Ilkarien), famous as a vital nesting site of the Ruppell's Griffon vulture, is situated under the huge Gol Mountains, slicing canyon and spectacular rock that b deep and narrow gorge cutting through high fault mountains.

Plate 15: Olkarien Gorge

Source: NCAA, 2019

The gorge was formed by tectonic faults, which opened a river through the core of the mountains. The river course is nea gorge extends 8 kms, and the walls of thes is a unique gorge of its kind in the entire Rift Valley Escarpment. On top of the mountains, there are primary nesting sites of the Ruppell's Griffon vultures. It is a place to see vultures soaring, circling and gliding down to their nests. The best time to visit the gorge is from March to April when the vultures are breeding.

3.2.7.4 Nasera Rock

Nasera Rock is a huge monolith jutting out from the plains to an elevation of 100m on the western side of the Gol Mountains, 27 kilometres north of Olduvai Gorge. The site of the rock has yielded archaeological resources since the 1930s, when excavations started around it consist of stone artefacts (nearly 300,000), bone fragments (over 150,000) and shreds of pottery dating back to about 30,000 B.C. Nasera Rock is also a spot for climbers and bird watchers. The eastern side of the rock is gentler and enables climbers to reach the top. There is rich bird life all the time around the lower part of the rock. During the wet season, the surrounding plains are green and full of wildebeests.

Plate 16: Nasera Rock

Source: NCAA, 2019

3.2.7.5 Shifting Sand

North of Olduvai Gorge on the plains is a spectacular moving ash dune, famously known as Shifting Sand. It is a remarkable crescent-shaped, black dune, composed of volcanic ash from the active Oldonyo Lengai, reaching about 9 metres high and stretching about 100 metres at the curves. The dune is being blown slowly westward across the plains, at the rate of about 17 metres per year.

Plate 17: Shifing Sand

Source: NCAA, 2019

3.2.7.6 Burial Mounds, Graves and Bao Sites

The Ngorongoro Crater area is rich in cultural sites often linked to local traditional rituals, such as the Datoga graves, which are an important pilgrimage site for the Datoga tribe. These graves belonged to a spiritual leader, Gitangda, and his son, who died over 170 years ago (betw their land against the Maasai in Ngorongoro. The Pastoral Neolithic is a period in East African prehistory during which people kept domesticated animals and probably practised cultivation. This period began about 3,000 years ago and continued into the early centuries of the occurrences are found either around settlement sites or in burials covered with stone cairns. These cairns or mounds consist of multiple inhumations with a wide range of grave goods – stone bowls, p semi-precious stones and pottery.

In the NCA, burial mounds belonging to th excavated in the hills situated in the eastern part of the crater. A total of 33 burial mounds belonging to this period have been found (Leakey, 1966; Sassoon, 1968; Mturi 1977, 1978, 1979). Stone bowls were also found in 1969 during construction activities in Lemala, but their provenance could not be determined. It is not known whether they came from a burial mound or a settlement site.

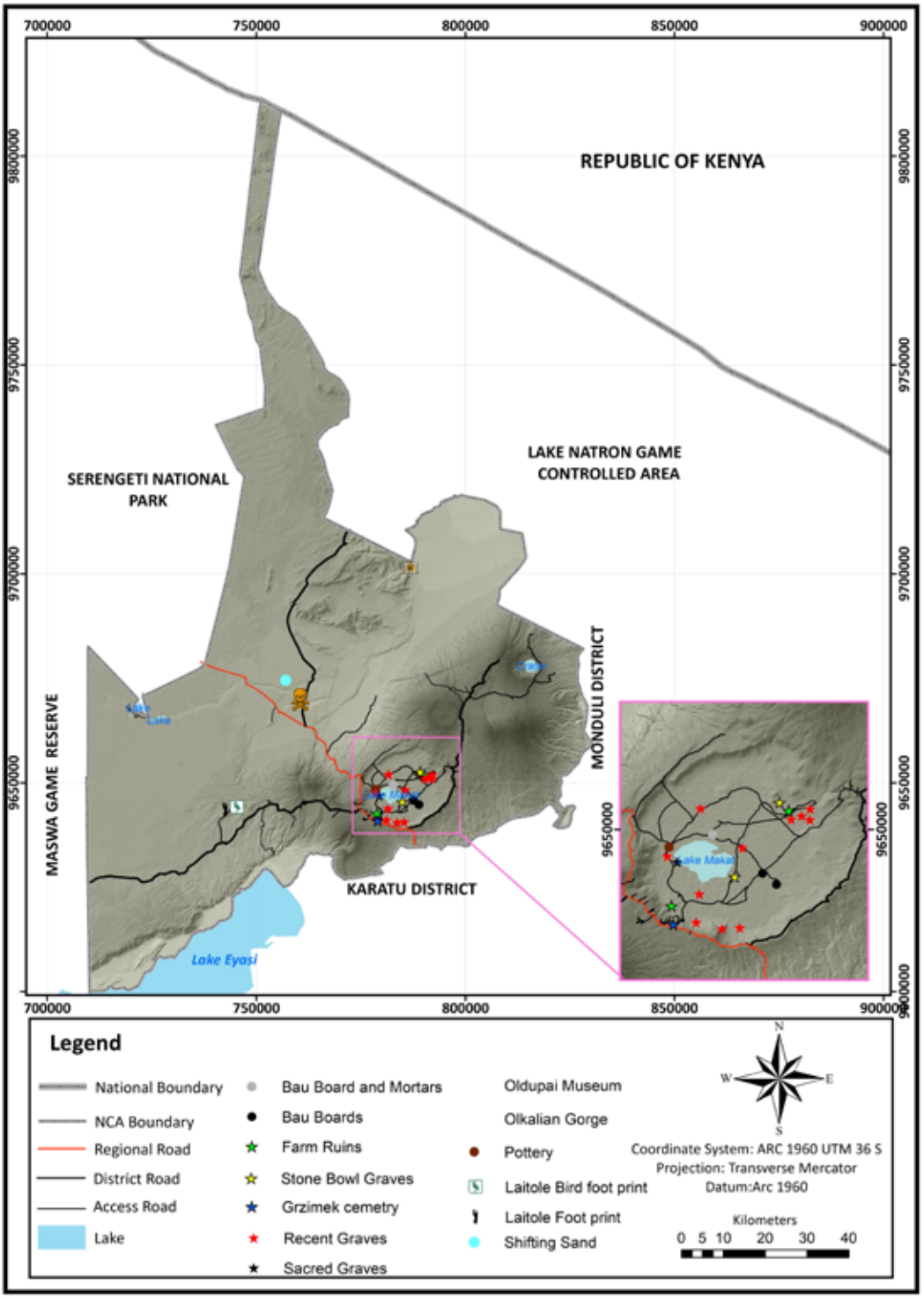
Other burial mounds have been found and crater, and these probably belong to the Lerai Forest have been atributed to the Ta Tree" campsite were identfed as being Gita his son, Magusachand. Both men were leader expulsion by the Maasai in the period 1836

3.2.7.7 Ndutu Archaeological Site

Ndutu is a site in northern Tanzania known for a 400,000-year-old human cranium and associated Stone Age tools discovered there in 1973. The skull displays traits of both *Homo erectus* and *Homo sapiens*, with a brain size intermediate between the two species. Like *H. erectus*, it has a large browridge, another ridge along the rear of the skull, and a thick-boned braincase. However, the shape of the braincase is more similar to that of *H. sapiens* in having vertical sides. During September and October 1973, A. A. Mturi and the Tanzanian Department of Antiquities conducted an excavation of the exposed fat Ndutu.

The excavation site was approximately 140 m^2 (1,500 sq ft) in area and had considerable amounts of lithic and faunal material on the surface; the Ndutu cranium was found on the first day of excavation. Mturi's excavation uncovered 270 lithic and faunal materials from the excavation site, of which 20 were defnitiv that it seems to form an evolutionary link between *Homo erectus pekinensis* and *Homo sapiens* having features in common with both hominid skulls discovered in Pleistocene deposits around Lake Ndutu.

Map 21: Cultural heritage resource



3.2.8 Cultural Heritage Resources outside NCA Boundaries

In 2013, the NCAA was handed over the management of the Olduvai and Laitole cultural sites from the Department of Antiquities (DOA), which is under the Ministry for Natural Resources and Tou made by the NCAA in the Olduvai and Laitole cultural sites, the Ministry for Natural Resources and Tourism decided (in 2018) to transfer all key cultural sites, which were under the DOA to the management of the NCAA, TANAPA, TAWA and TFS. The NCAA was handed over th cultural heritage sites found outside its bounderies of management. These sites are the following;

a) Mumba Rock Site
b) Engaresero Footprints Site
c) Engaruka Historical Site
d) Kimondo Meteorite Site in Mbozi
e) Amboni Caves in Tanga

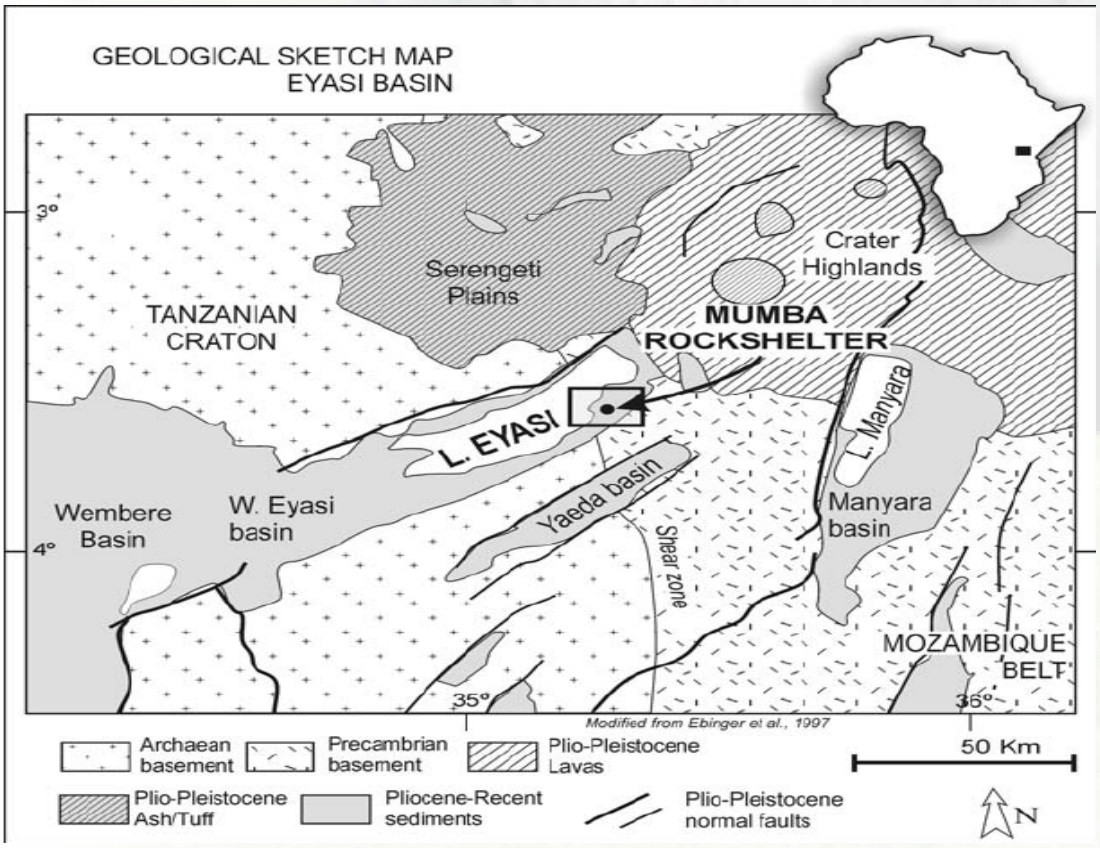
3.2.8.1 Engaruka Ruins Site

Engaruka Stone Age site is an archeological and historical site dating back to the 14th – 18th century. It represents settlement with remains of irrigation furrows. The site, recognised under Government Notice (G.N) No. 186 of 1937, is situated below the east-facing escarpment of the East African Rift, at about 1000m above sea level. It dates from 1400 to 1700 AD. West of Engaruka is the Crater Highlands, with a number of volcanoes reaching 2500m to more than 3600m above sea level. The highlands receive high rainfall, especially on the east-facing slopes. Therefore, most rivers draining from the Crater Highlands fow eastwards, dissecting deep valleys on For example, the fwa teirs hedst hat fed the i at Engaruka are located on the eastern slopes of Lolmalasin, a 3648 m high extinct volcano in the Crater Highlands. The site is fashioned by the remains of a system of ancient felds and carefully pl being divided and terraced with stonework from the hills slope. Intensive and sustained research by the British institute in Eastern Africa has reconstructed a system of land use based on irrigation farming at Engaruka, which provides testimony to the ingenuity of ancient farming systems and practices in east Africa.

3.2.8.2 Mumba Rock Shelter

Mumba Rock-shelter is located in Mang'ola village Basin at the south-west of Karatu District centre, Arusha region in northern Tanzania. It is about 2.5 kms from the current Lake Eyasi shore, and about 62 kilometres south of Olduvai Gorge (see Plate 18). It presents one of the richest and most complete archaeological sequences in East Africa for the Middle Stone Age through the Iron Age. Mumba area as part of Eyasi region is widely recognised for its extensive provision of significant information on rock art and Sto of subsistence patterns, including hunting and gathering technologies. Ludwig and Margit Kohl-Larsen pioneered research activities in this area in 1933 and 1939. Their research expeditions compiled important archaeological and paleontological records, including homimin remains and collections representative of the history of how humankind evolved and dispersed across the planet.

Plate 18: Locaton of Mumba Rock-Shelter



Source: Binger E. et. al. (1997).

3.1.3.3 Engaresero Footprints Site

The Engaresero site is located on the southern shore of Lake Natron within the Natron-Engaruka explosion crater area in Northern Tanzania. The site is

bounded on the west by the Nguruman Escarpment, the western border fault of the East African Rift (EAR) in southern Kenya and northern Tanzania, and on the east by two extinct shield volcanoes, Gelai and Kitumbeini. The area is volcanically active due to lithospheric thinning and extension along the rift since its inception during the Pliocene (Dawson, 2008). The Engaresero footprint site contains trace fossils of modern humans, and with over 300 human prints uncovered, there are likely more buried underneath the northern sand dunes. It is, currently, the most abundant late Pleistocene *Homo sapiens* footprint site in Africa, and, uniquely, it has the potential to shed light on human behaviour in the latest Pleistocene, as well as provide evidence of human interaction with the dynamic nature of the shoreline of Lake Eyasi-Manyara time. Today, the site faces many conservation challenges such as uncontrolled human activities including vandalism, and encroachments especially from grazing domestic animals and roving wild animals. There are also natural disasters, in particular flooding, which pr tuff. After being handed over to the NCAA, the department of Cultural Heritage is set to curb conservation challenges facing this site.

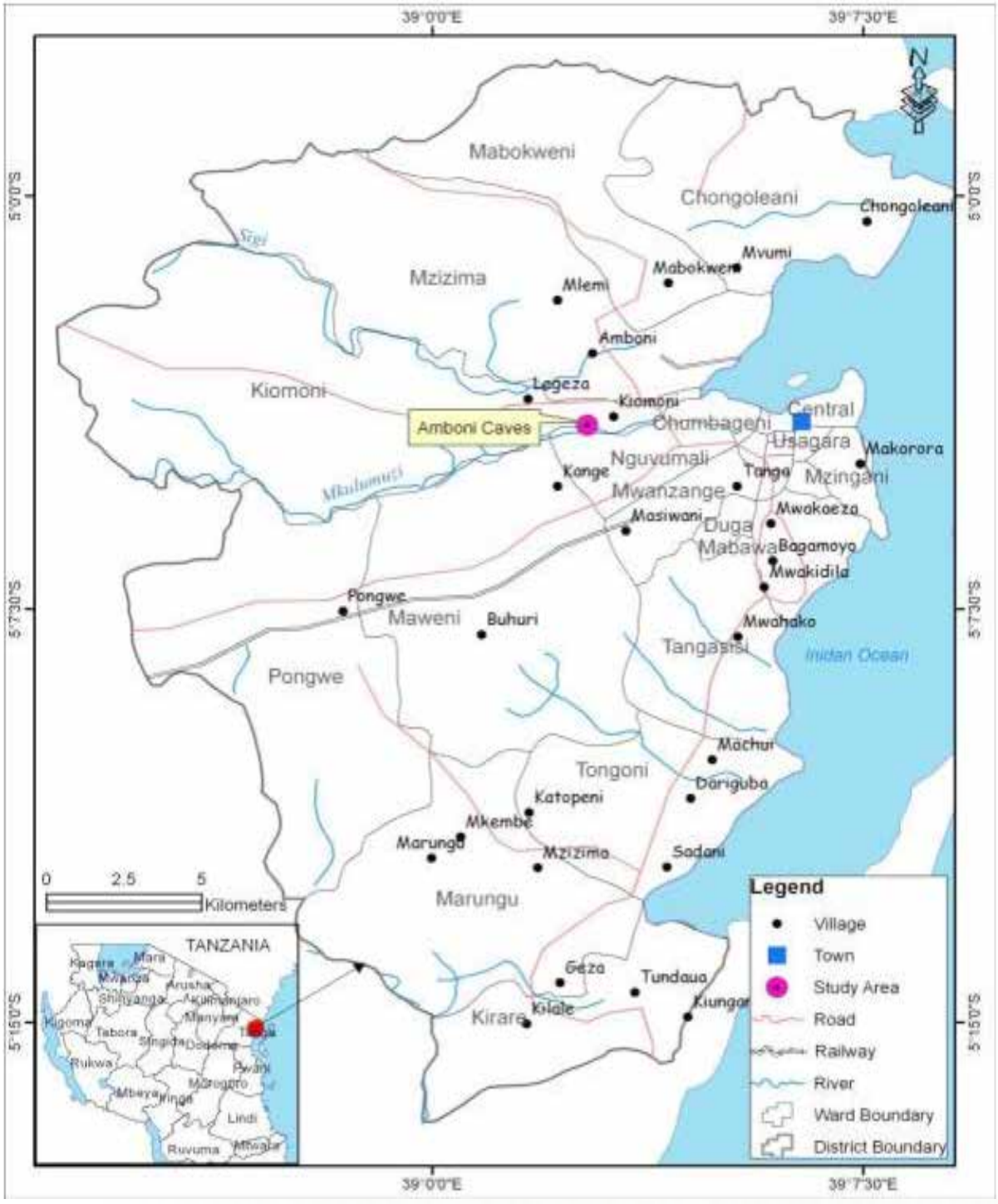
3.1.3.4 Amboni Caves

Amboni Caves are the most extensive limestone caves in East Africa located between the Mkulumuzi and Sigi rivers in Tanga Region on the coast of the Indian Ocean. Their estimated geographical (See Map 22). The caves are in Kiomoni village and named after neighbouring Amboni village. Situated nearly 9 kilometres from the centre of Tanga Municipal along Tanga-Mombasa Road, the caves were formed nearly 150 million years ago during the Jurassic Age in terms of geological timescale. They cover an area of about 234 square kilometres. The site was recognised by the Government Notice No. 186, and today is one of the key tourist destinations in Tanga itself and among other coastal regions. It also attracts tourists from upcountry and foreigners. Among of the key tourists to this site are primary secondary school students and university students.

As part of the national heritage, caves are distinguished by their values and significance. For instance, they have relig of Tanga and nearby regions. It is reported that for many years, ethnic groups including Sambaa, Bondei, Digo and Segeju, who lived near these caves for a long time, used them for ritual practices and offerings. Administratively, the caves were declared protected monument in 1937 under the Monuments Preservation Ordinance (MPO), and in 1964, the Government of Tanzania handed them over to the Department of Antiquities. They are protected under the Antiquities Act

of 1964, amended 1979. Accordingly, with respect to ministerial directives, the caves are now managed by the NCAA, which was also recently appointed as an honorary warden of this site amongst others, with close assistance from the Antiquity Department, an agency responsible for policy and legal issues.

Map 22: Locaton of Amboni Caves in



Source: Adopted and modifed from Peter

3.1.3.5 Mbozi Meteorite

Mbozi Meteorite is an ungrouped iron meteorite found in Tanzania. One of the world's largest meteorites, variously estimated as the fourth largest to the eighth largest, it is located near the city of Mbeya in Tanzania's southern highlands. The meteorite is 3.30 metres (9.8 ft) long, 1.22 metres (3 ft 3 in) high, and weighs an estimated 12 metric tonnes, which makes it one of the 10 heaviest known meteorites on Earth.

Mbozi, which locals call *kimondo*, did not become known to outsiders until the 1930s, when it was discovered by scientists. It is named after Mbozi District, in Songwe region (Tanzania). Mbozi consists of meteoric iron with small silicate inclusions. The meteoric iron has a concentration of nickel (8.69%), iron (90.45%), copper (0.66%), sulphur (0.01%) and phosp an ungrouped iron meteorite and shows similarities to IIF iron meteorites, the Eagle station pallasites and a few other ungrouped iron meteorites. The object is one of the tourist attractions in the southern highlands in Tanzania. It is also recognised as one of the National Heritages protected by the Department of Antiquities, under the Ministry of Natural Resources and Tourism (MNRT).

Plate 12: Mbozi Meteorite in Mbozi Distric

Source: NCAA, 2019

3.1.3.6 Ngorongoro Lengai UNESCO Global Geopark

The Ngorongoro Lengai UNESCO Global Geopark is located in the north-west part of Tanzania. It is bounded to the north by Lake Natron and the Kenyan border, and to the north-west by Serengeti National Park, Lake Natron to the east, the left arm of the Great Rift Valley to the south and Maswa Game Reserve to the west. Its highest point is the Oldonyo Lengai (2,962 m), a sacred mountain for the Maasai population, which is also a unique active volcano of calcarenite. The geopark covers an area of 11.895 sq km, with a population of 230,506 people, mainly Maasai population. Ngorongoro Lengai UNESCO Global Geopark encompasses the districts of Ngorongoro, Karatu and Monduli in the Arusha region. Its altitudes range from the lowest areas, the main crater (600 m), to the highest point, the Oldonyo Lengai (2,962 m). The UNESCO Global Geoparks Council, at its meeting on 16 and 17 September, 2017, in the Zhijindong UNESCO Global Geopark, China, decided on the status of Ngorongoro-Lengai Aspiring Geopark. Ngorongoro-Lengai UNESCO criteria and was approved as a UNESCO Global Geopark on 18 April, 2018.

The main economic activities in the Ngorongoro-Lengai UNESCO Global Geopark include pastoralism, which is deeply embedded in the culture of the Maasai and Datoga, agriculture, tourism and trade. One of the geopark's central features, the Ngorongoro Crater, harbours a great diversity of wildlife species, like elephants, black rhinos, lions, gazelles and other large mammals, living in co-existence with humans.

Unique Geological Heritage

The geopark geological history began 500 million years ago with granites and gneiss, which can be seen in the north (Gol Mountains) and the west around Eyasi lake. The geopark territory lies in the eastern branch of the East Africa Rift. Rifting started in the Early Miocene (20 million years) and continues today. Geopark landscapes are connected by active volcanism, which was still evident 2,5 million years ago, and has generated different craters: Ngorongoro caldera, Olmoti and Empakaai Crater. The Oldoinyo Lengai is active and its last eruption was in 2013.

A Cradle of Mankind

These erupting volcanoes that formed the Ngorongoro landscapes were watched by earliest prehistoric men. Along the Geopark North Route is the world-famous Olduvai Gorge, which contains some of the oldest evidence of hominoids, preserved by the volcanic ash, 1.8 million years ago. The Geopark West Route also offers a unique site of human history, where one of the greatest

paleoanthropological discoveries was made footprint, proving that hominids walked, at this time, on their two feet. Their preservation is once again due to the volcanic ash. These two sites are part of the world famous UNESCO World Heritage Sites (1979).

A Human Diversity

The geopark population is mainly composed of the famous Maasai people, who are pastoralists, and originated from the Nile area. They came here during the eighteenth century. Datoga and Irawq are also present. Moreover, the Hadzabe tribe, an autochthonous indigenous ethnic group, is still found in Eyasi area. With a population of less than 1000, they are hunter-gatherers and are not closely related to any other people. Their language has clicks, and they may be related to the Pygmies.

Cultural Heritage

Various cultural heritage sites are also to be found in the geopark. The north route offers the oldest cultural boma of the territory (1992) in Seneto, as well as traditional wheels at Olkarien Gorge. In addition, the Datoga graves in caldera and west route are important pilgrimage sites for Datoga tribes. An old construction from the German period (1899) can be seen along the caldera route.

Intangible Heritage

Due to a long and diversifed human presenc heritage. Legends, tales, songs and traditional dances are essential to the identity of the different tribes. Sacred trees can be seen along the different geopark routes, and traditional beekeeping, a Datoga blacksmith and Hadzabe hunting. Ngorongoro-Lengai UNESCO Global Geopark is divided into three routes:

a) Geopark North route (Olkarien Gorge site, Nasera rock, Angatakiti panorama, Cristal biotite hill, Shifting Sand, Bao site, Soitoo quartzite hill, Leakey camp, Olduvai Gorge and Museum, Serengeti plains, Seneto cultural boma, Malanja depression, Rim Forest panorama and Grimezk grave)

b) Geopark Caldera route (Empakai lake, Oldonyo Lengai panorama, Olmoti waterfall, Irkepus village panorama, Round Table hill, Seneto spring, Munge River, Magadi lake, Datoga grave, Datoga sacred tree, Lerai forest, Old German house, Ngoitoktok, North rim panorama, Pillar wood site and Acacia rim)

c) Geopark South route and Geopark Caldera route (Endoro waterfall, Elephant cave, Gibb's farm, Makonde carving, Iraqw brewery, Mang'ola spring, Datoga culture, Datoga blacksmith, Hadzabe culture and onion plantation)

CHAPTER FOUR: EXISTING CHALLENGES

4.1 Introduction

The existing challenges facing the NCA were assessed based on the three legal mandates and purpose of the NCAA. The mandates of the NCA are to promote cultural and biodiversity conservation in the area, tourism and the interests of resident communities. The purpose is to achieve balance between preservation of cultural and biodiversity resources, promotion of tourism and human development in a sustainable manner.

Challenges, problems, concerns and issues were also assessed based on the global standards of human development, biodiversity conservation and tourism development. Global standards of in the UNDP global goals of conservation, which are outlined in the UNESCO designations documents and by the UNDP. Tourism global standards are clearly stipulated by the World Tourism Organization as well as UNESCO. In Tanzania, various government development policies, plans and strategies underline human development, tourism and conservatio of international standards. The CCM election manifesto 2020 also stresses the challenges and promises of the government

The main challenge that adversely affects every facet of the NCA is the changing relationship between the major factors and variables of the biotic and abiotic resources. These factors include the growing human population and human uses, change in the culture of the NCA, the growth of wildlife, reduced vegetation cover, changing rainfall patterns in and around the NCA, increased number of invasive species and changing distribution and movement of wildlife. Unfortunately, the multiple land use policy assumed that all the above factors would remain steady.

However, these changes affected the relationship between traditional land use, which caused signifcant confcts not seen policy was conceived 60 years ago. These c and complexity as the pilot multiple land use model continues to be implemented. The balance between human development, preservation of cultural and biodiversity resources and tourism development cannot be achieved. It has been witnessed over the past 60 years that the balance is skewed in favour of tourism development, culture and nature conservation against human development. This suggests that the NCA is a conservation area and not a development site.

It is also true that since its establishment in 1959, there has been an increase in the population of people in the NCA. The natural growth in the numbers of indigenous residents and non-residents, who remain in the conservation area after they retire, small business owners and their families and immigrants all account for the fast-increasing human population in the NCA. This leads to more human activities and pressure on natural resources, in turn causing greater environmental degradation and disease outbreaks. The average growth rate for people residing in the NCA between 1999 and 2002 was estimated at 3.5% (NCAA, 1999; URT, 2003). In 2017, the NCA's population stood at 93,136 people, meaning that the overall population growth rate for Ngorongoro Division was 5.7% for the period 2012–2017. This a Ngorongoro is growing at 5.7% every year, which is almost two times the National Inter-Censual Population growth rate of 2.7 %. Although the available data are scant, illegal immigration of non-indigenous people into the NCA is a continuing challenge, which threatens not only the conservation values of the NCA, but also reduces the resources available to indigenous residents. For the period between 1959 and 2017, the size of the area remained the same (8,292 Km^2). The authority cannot meet the demands of people living in the NCA for food and wealth. Food insecurity has also increased tremendously due to the growth in the human population, changing cultural values and restrictions imposed by the NCA Act. The number of wildlife, species composition and distribution, climatic conditions and vegetation cover have also changed since 1959, making the area unsuitable for human development. In other words, the balance between preservation, tourism development and development of people cannot be achieved. The multiple use policy must be revisited and revised perhaps for strictly sustainable preservation, tourism and human development.

4.2 Human Development Challenges

The main challenges facing human development in the area concern community and livestock health, education, food security and creation of community prosperity. Assessment of all these varia performance of human development based on all standards. The nature of the current policy (multiple land use model) in the NCA and legislation restrict any efforts to address issues related to human development. Changing the legislation would turn the area into a development site and degrade its biodiversity and cultural values. NCA problems are structural and, thus, the policy must be reformed. On the other hand, the current legislation has secured biodiversity and tourism endeavours despite the fact that human development endeavours have been severely undermined. Specifc pro dimension are outlined as follows.

4.2.1 Human and Livestock Diseases

Apart from diseases transmitted from wildlife, most diseases in the NCA partly result from shortage of food and the inability of people to access adequate, safe and nutritious food. While malnutrition is linked to child deaths in the NCA, adults who are as undernourished as children are also at risk of developing diseases such as obesity, diabetes and cardiovascular diseases. In 2017, malnutrition in the NCA was widespread in Enduleni, while cholera outbreaks, which are common, were reported in many wards in the NCA, particularly, Enduleni, Kakesio, Misigiyo, Alaitole and Ngorongoro. Cases of cholera have for a long time increased because of people drinking and eating contaminated water and food.

Due to diseases and lack of pastures and water that resulted from prolonged drought, the NCA witnessed about 80,000 deaths of cattle in 2017. Diseases transmitted from wild animals, such as anthrax, ECF (East Coast Fever), rabies, Rift Valley Fever, malignant catara fever, CBPP (Contagioius Bovine Pleuropneumonia) lung disease and Food and Mouth Disease (FMD), are the cause of many livestock deaths in the NCA (TAWIRI, 2013). According to data obtained from the NCAA (2018), most common diseases affecting wild animals, which are also common among humans, include Rift Valley Fever, trypanosomosis, FMD, rabies, anthrax and Brucellosis. For small stocks such as goats and sheep, problematic diseases are heart-water, Pneumonic Pasteurellosis, CBPP, helminthosis, diarrhoea, foot-rot, Rift Valley Fever, anthrax, mange and feas. At least 183 peo
anthrax between January and September 2017, of which seven died. However, efforts to control both human and livestock diseases are inadequate given the number of experienced staff/doctors and equipment (including medicines and laboratory tools) available in different health service centres in the NCA.

4.2.2 Intricate Environment for Social Services Provision

The mobility of pastoralists, both as regards NCA residents and the neighbouring community, makes the provision of health care, education and other social services more diffcult. Movements are seas
are adjusted by pastoralists depending upon the availability of water, forage, the threat of cattle raids and other factors,
to understand or predict. Moreover, poor and destitute families among NCA residents have the greatest need for social services, but often have the least access for economic or cultural reasons. Despite the presence of health centres or dispensaries in most settlements in the NCA, the quality of the service is

still low, thus leaving Endulen and Nainokanoka hospitals the most visited and congested health facilities in the NCA.

Traditionally, pastoralists resist sending their children to school because they want them to herd livestock and perform other activities. In the past three years, school enrolment for children has increased due to a free education policy, meaning that school fees are borne by the government. Although the number of children attending schools has been increasing, dropouts are high particularly among girls (Maro, 1997; NBS, 2017).

The NCAA and the Ngorongoro District Council have overlapping responsibilities and authorities for providing social services in the NCA. Ambiguity over the role of each agency has often resulted in gaps in service provision or overlaps. Existing social services facilities within the NCA of the residents due to conservation interests. Many residents, particularly in the south-west (Olpiro and Masamburai) and northern part of the NCA (Nayobi and Kapenjiro), have to walk for many hours to reach hospitals. Housing for health and education workers in the NCA remains generally inadequate. Poor work and housing conditions discourage well-trained people from working in the NCA, as in much of rural Tanzania.

Access to clean water has been a challenge for many households in the NCA. In the past 10 years, the government through the NCAA has facilitated the establishment of 52 water points, 31 water tanks and 15 bore holes, which are used for domestic consumption by the community and lodges in the NCA. Water for domestic consumption is also delivered through natural wells and streams. However, there is uneven distribution of water services for domestic consumption. Due to scattered settlements, some households are far away from settlement centres, thus they must travel long distances to access these services. Many water taps are found in settlement centres and some schools.

4.2.3 Increasing Human Population

Since its establishment in 1959, there has been an increasing population of people in the area. The natural growth in numbers of NCA indigenous residents and non-residents who remain in the conservation area after they have retired, small business people and their families and immigrants, all account for fast human population growth in the NCA. This places pressure on natural resources, thus causing increased environmental degradation and diseases outbreaks. The average growth rate for people residing in the NCA between 1999 and 2002 was estimated at 3.5% (NCAA, 1999; URT, 2003). In 2013, the NCA's population stood at 87,851 people, meaning that the overall population

growth rate for Ngorongoro Division was 5
This also meant that the population of Ngorongoro was growing at 5.7% every year, almost two times the National Inter-Censual Population growth rate of 2.7%. Although data are scant, illegal immigration of non-indigenous people into the NCA is a continuing challenge. Illegal immigration threatens not only the conservation values of the NCA, but also reduces the resources available to NCA residents. The NCA should emphasise the voluntary relocation of people outside the NCA.

4.2.4 Large Number of Livestock

According to a survey by the National Bureau of Statistics (NBS) 2017 Census, the NCA accommodates 238,826 cattle *(238,826x0.72= 171,955 TLU)*, 226,260 goats *(226,260x0.072 = 16,291 TLU.)*, 344,373 sheep *(344,373x0.072 = 24,795 LU.)* and 22,104 donkeys *(22,104x0.72 = 15,919 LU.)* within its areas of jurisdiction. All these livestock amount to 228,960 TLUs. The increase in herds of cattle was 89.6% from 2012 to 2017 and 81.6% from 2013 to 2017. The carrying capacity for the NCA, which falls within arid lands agro-ecological zone (excluding the northern highlands forest area), with unimodal annual rainfall of 200–600mm, is estimated (that is between 7 and 20 TLU/Km^2). This is equivalent to 7ha/TLU. Therefore, considering the carrying capacity of 7 ha/TLU, a total of 228,960 TLUs will require an area of 228,960 x 7 = 1,602,720 hectares (which is 193.3% of the total land (area) of the NCA). The area zoned for livestock keeping
area zoned for settlement (development zone), which was about 7,000Km^2 or 700,000 Ha. This area was not enough to accommodate 228,960 TLUs before 2017, in accordance with the carrying capacity of 7 ha/TLU. Due to this fact, even if the whole of the NCA (8,292 Km^2) were allocated for grazing, it will still not be enough for the available number of livestock. This implies that the NCA is extremely overstocked and immediate measures are required to address the problem for conservation and human development.

4.2.5 Food Insecurity

Food security is complicated by many different food production factors. In 1959, when the NCA was established, the NCAA did not supply food to local residents. The human population in the NCA was fewer than 8,000, and they depended purely on livestock and their products to survive. Fifty-nine years later, the number of people increased substantially to 93,136 (NBS, 2017), and dependence on livestock as the sole source of food had decreased markedly. In order to protect the biodiversity and cultural resources of the area, the legislation

that established the NCA, the Ngorongoro Conservation Area Act (Cap.284 R.E., 2002), included prohibition against agricu climate change and ecological disturbance, income poverty, livestock production failure, poor food habits, choices and preferences, misuse of incomes and food, lack of areas for crop production, inadequate economic opportunities for the people and poor rangelands – resulted in s people in the NCA. The Authority responded by increasing the supply of food through purchases and supplies of maize to the local population. Nonetheless, different stakeholders have criticised the concept of supply of food for free or at subsidised price that is not sustainable and creates a dependence syndrome.

Historically, cattle have been the basis of economy and food security in the area, but their numbers remained stable between 1980 and 1992, resulting in tremendous decrease in livestock per capita. Although a census report undertaken by the NBS in 2017 showed an increase in livestock in the NCA, when compared with an increasing human population, the number of cattle per person had decreased. This means dependency on livestock for food is also increasing despite their poor quality caused by diseases such as tick-borne. Declining water and pasture availability resulting from recurrent drought is another factor. The NCA indigenous resident pastoralists have increased their reliance on small stock, primarily goats and sheep, which are less prone to diseases, but the total livestock per capita in the area has continued to decrease.

Although the NCA indigenous resident pastoralists have depended largely on their cattle, grains and other vegetable products have always been an important supplement to their diet. In the past, very few engaged in cultivation, and most agricultural crops were acquired through trade with agricultural tribes. As relative livestock numbers declined in recent decades, NCA indigenous resident pastoralists' dependence on maize, potatoes and other crops increased. The 1975 amendments to the NCA Ordinance establishi ban on cultivation within the conservation area. This left some households with no alternative to livelihood other than livestock keeping, while other households resorted to beekeeping, employment and tourism-based activities.

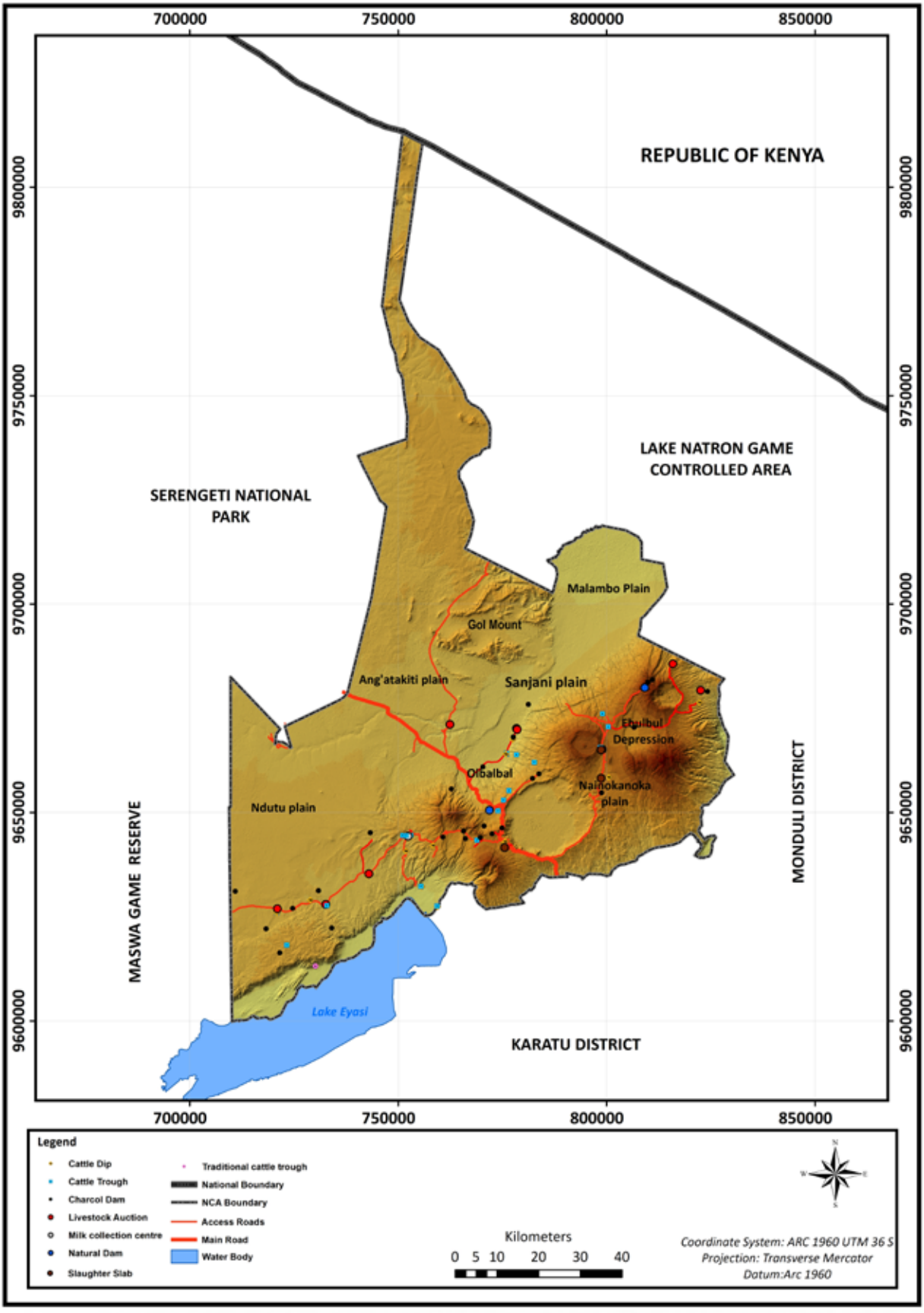
In order to complement and ensure food security for indigenous residents, the government through the NCAA has been providing subsidised food (cereals) to the community on a weekly basis. However, many residents claim that the cereals provided are not enough, and do not form part of a balanced diet that a human being needs for good health. Prohibiting cultivation has resulted in reliance on aid and acute shortage of food and poor diet for many families in the NCA.

4.2.6 Inadequate Livestock Services

Inadequate pastures and diseases have led to deterioration in the quality of livestock in the NCA. Many indigenous resident pastoralists have suffered significant losses of cattle due to diseas
In 2017, about 80,000 cattle died due to drought and diseases leaving some families in dire economic and nutritional circumstances because of livestock losses. Although veterinary services have improved in recent years, they are still inadequate to meet the demand. Residents are particularly concerned about the availability of extension services as well as the scarcity and expense of veterinary drugs. The current infrastructure for livestock services is in need of improvements. Field surveys identifed 23 c
for livestock, 13 cattle dips for the treatment of livestock, 12 cattle crushes and 18 cattle troughs for livestock (Map 23). Water troughs and charcoal dams ensure the availability of plenty of water especially during drought. However, due to uneven distribution of these services, some herders travel long distances in search of water or to access established livestock services in other areas.

During drought, many water ponds and charcoal dams tend to dry up. This forces many livestock herders to move their herds into the forest areas in search of water. Efforts to address this challenge need to be strengthened by increasing access to livestock services in the NCA, while encouraging the community to keep a manageable number of livestock according to the carrying capacity of the area. All this adds up to severe food shortage and economic hardship for people in the NCA.

Map 23: Distributon of livestock serv



4.2.7 Education Constraints and Illiteracy Rate

Education indicators show limited progress. As regards the largest proportion of the population among both sexes, 67.5% have never attended school (NBS, 2017). The majority of the population in Ngorongoro Division has poor access to schooling. The proportion of females who have never attended school is 75.3%, compared with 59.1% for males (NBS, 2017). This is attributed to the customs and traditions of the NCA community, which discourages girls from schooling. The percentage of the female population who have attained primary level education (standard 5 to 8) is 28.0%, while that of males is 48.3%. This means that about 72.2% of females in the NCA are illiterate. The percentage of the population aged 15 years or above who are illiterate (63.4%) is about two times the population who are literate (36.6%). The highest literacy rate was observed in Ngorongoro ward (50.3%) followed by Endulen (43.5%) and Kakesio (40.7%). Alailelai (24.7%) and Olbalbal (26.5%) are the wards with the lowest literacy rate in the NCA. Generally, in all wards, males are much more literate than females except in Eyasi ward where there is a small difference between males and females.

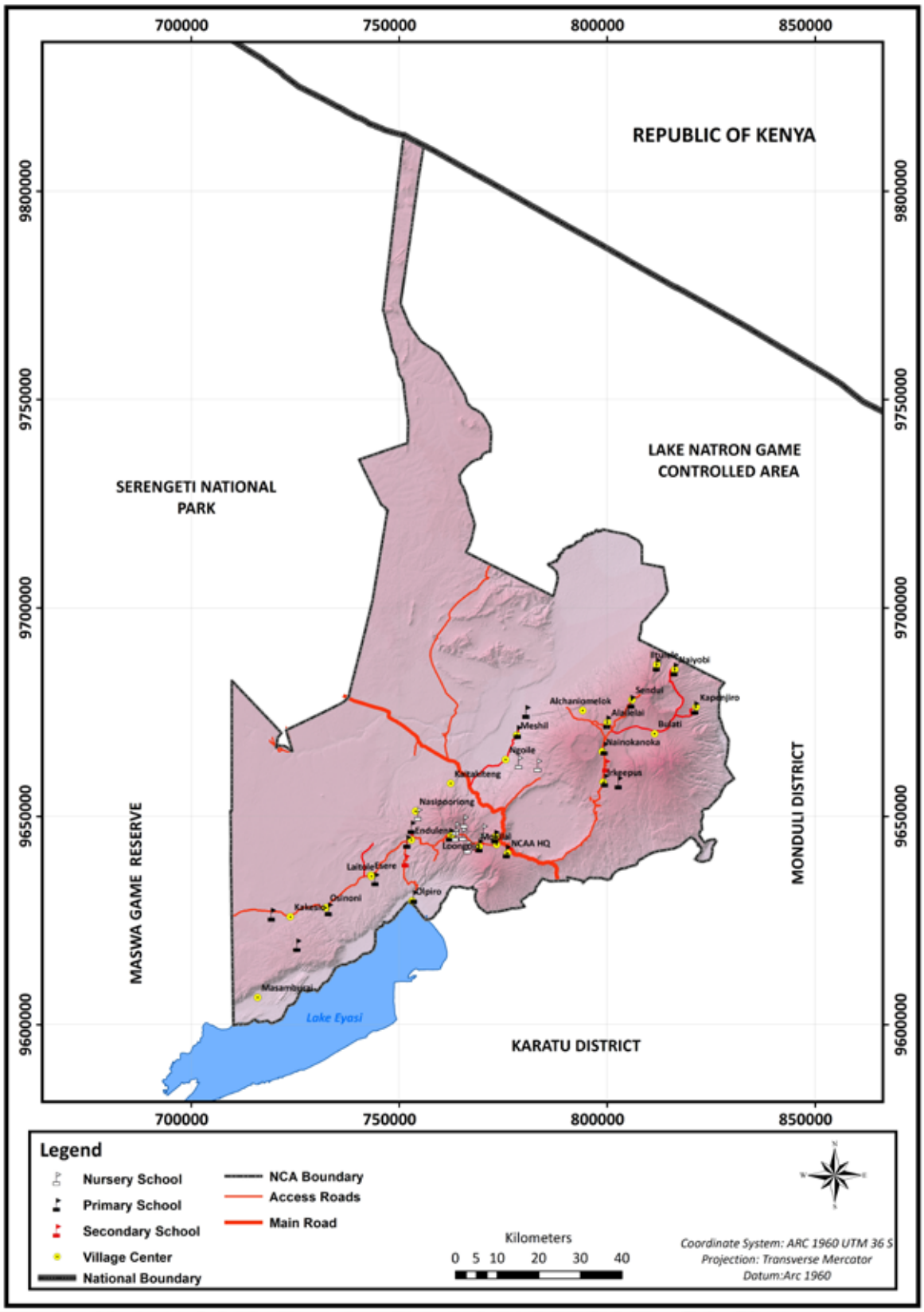
The high level of illiteracy is partly attributed to environmental limitations, which means administering schools and providing good education in the NCA is very expensive to achieve. Establishing an education infrastructure with better facilities and teaching staff and a safe environment for children going from their homes to schools is complicated by the inaccessibility of these areas due to ecological constraints and physical isolat for human development in accessible areas, which are devoid of wildlife, would allow the government to provide an improved educational environment for effective learning. This should perhaps go hand-in-hand with provision of boarding schools outside the NCA.

Progress in education has not been achieved in recent years despite the fact that access and enrolment have increased at the primary and secondary levels in Ngorongoro. Education is traditionally not highly valued, but in recent years many parents have demonstrated strong support for schooling. However, there remain a number of critical challenges and constraints to achieving the educational vision and goals in the NCA. There is wide disparity in access to, and duration of, quality education opportunities for different children and population groups. A range of factors, including gaps in teacher education and management, limited resources, weak school management, language in education and inclusive education, have constrained progress in quality development. There are challenges in terms of capacity for managing, supervising and monitoring from

the school/community to the district level. In particular, schools are understaffed and under-capacitated in relation to their pivotal roles. There has been limited exposure to approaches as taken in other places. Institutional structures are not conducive to participation or collaborative working across levels or sectors in Ngorongoro.

A survey conducted by the National Bureau of Statistics (NBS), in 2017, showed that 64% of the population in the NCA were illiterate. However, there are 21 primary schools and two secondary schools in the area (Map 24). The high level of illiteracy is partly due to ecol and very expensive to administer schools and provide good education in the NCA. The provision of an education infrastructure and facilities, better teaching staff and a safe environment for children going from their homes to schools is complicated by the inaccessibility of these areas due to ecological constraints and physical isolation. The allocation of in accessible areas, which are devoid of wildlife, would allow the government to provide an improved educational system for effective learning. This should perhaps go hand-in-hand with provision of boarding schools outside the NCA.

Map 24: Distributon of schools in t



4.2.8 Human-Wildlife Negative Interactions

In a multiple land use area where pastoralists exist alongside wildlife, contacts between wild animals and livestock cannot be avoided. Human-wildlife

cohabitation and the associated interactio
to an animal depending on its fexibility.
serious negative interaction between huma
Confict is here defned as any interaction
results in negative impact on social, economic or cultural life. This may lead to the transmission of disease from both sides, loss of human life and livestock and the killing of wildlife for food or defence.

The results of research studies carried out between 1998 and 2017 on animal diseases in the NCA (NCAA-SUA, 2004; NCA-TAWIRI, 2013) indicated that the main disease affecting cattle is tick-borne, especially ECF, anaplasmosis, babesiosis and theilorisis. Others are trypanosomosis, F&MD, anthrax, MCF, CBPP, helminthosis, mastitis, tuberculosis, eye infections and otitis. In terms of small stock, problematic diseases are heart-water, pneumonic pasteurellosis, Contagious Caprine Pleural Phenomonia (CCPP), helminthosis, diarrhea, foot-
rot, Rift Valley Fever, anthrax, mange an
from the NCAA (2018), the most common diseases affecting wild animals that jump from livestock, and which are also common among human beings, are mange, Rift Valley Fever, babesiosis, trypanosomiasis, canine distemper, foot and mouth disease (FMD), rabies, anthrax and brucellosis.

In August, 1998, CCPP was offcially confrm
the frst outbreaks occurred in Ngorongoro
(NCAA-SUA, 2000). Amongst efforts to control diseases, in particular tick-borne, pastoralists in the NCA have sprayed animals with acaricides. Some of the animal diseases are new and others are recurring. Efforts to control major diseases affecting herds, especially tick-borne, are inadequate. This is evidenced by the high mortality of 80,000 cattle in 2017.

It is further the case that, in the recent past, the number of livestock killed by wildlife increased tremendously. The number of people killed or injured by wildlife is also on the rise. For instance, 14 people were injured by wildlife, while six people were killed by wildlife between 2014 and 2018. Coupled with increasing zoonotic diseases transmission, negative human and wildlife interactions require separation of the land where people reside from wildlife through effective zoning.
Common diseases in the NCA are presented i

Table 29: Common wildlife diseases

No.	Disease	Vecto	Crausatve Age	Mhots Afected Areas
1.	Anthrax	-	Baccillus anthracis	Low land areas such as Kakesio, Enduleni, Ndutu, Alaitole and Albalbal
2.	Brucellosis	-	Brucella Spp	Whole area
3.	Rabies		Virus (Lyssa	Whole area Spp)
4.	Foot and Mout Disease (FMD)	-	Viruses (aph the family	Whole area virus of Picornaviridae)
5.	Canine Distemper	-	Viruses	Whole area
6.	Typanosomos	Tsets fly	Protozoa (Ty Spp)	Enduleni, Olpiro, Kakesio, Mokolal a Misigiyo
7.	Babesiosis	Ticks	Protoza (Bab	Whole area Spp)
8.	Rif Valley	Fever	Viruses	Whole area
9.	Mange	Mite	Parasite (Ps sarcopts Spp)	Whole area goats /

Source: NCAE, 2018

Table 30: Wildlife diseases afectng

No.	Name of disease	Vecto	Causes / Causa	Mos tAfe	ted Area
1.	Anthrax	-	Baccillus anthracis		Low land areas such as Kakesio, Enduleni, Ndutu, Alaitole and Albalbal
2.	Brucellosis	-	Brucella Spp		Whole area
3.	Rabies	-	Virus (Lyssa		Whole area Spp)
4.	Typanosomosis	Tsets fly	Protozoa (Ty	Enduleni, Spp)	Olpir Kakesio, Mokolal Misigiyo
5.	Tuberculosis	-	Mycoplasma tuberculosis)	(Mycoplasma	Whole area
6.	Rif Valley	Fever	Viruses		Whole area

Source: NCAE, 2018

Table 31: Common Livestock Diseases

No.	Disease	Vector	Causative agent	Most Affected Areas
1.	Anthrax	Soil born disease	Baccillus anthracis	Low land areas such as Kakesio, Enduleni, Ndutu, Alaitole and Albalbal
2.	Brucellosis	-	Bacteria (Brucella Spp)	Whole area
3.	Tuberculosis	-	Mycoplasma (Mycoplasma tuberculosis)	Whole area
4.	Rabies		Virus (Lyssa viruses Spp)	Whole area
5.	Foot and Mouth Disease (FMD)	-	Viruses (aphthovirus of the family Picornaviridae)	Whole area
6.	Helminthiosis	Carnivals, Flees	Worms	Whole area
7.	Typanosomosis	Tsetse	Protozoa (Typanosoma Spp)	Enduleni, Olpiro Kakesio, Mokola and Misigiyo
8.	East Coast Fever (ECF)	Ticks	Protozoa (Theileria Spp)	Whole area
9.	Anaplasmosis	Ticks	Protozoa (Anaplasma Spp)	Whole area
10.	Babesiosis	Ticks	Protoza (Babesia Spp)	Whole area
11.	Contagious Bovine Pleural Phenomena (CBPP)	-	Mycoplasima (Mycoplasma Spp)	Whole area
12.	Contagious Pleural Phenomonia	- Caprine	Mycoplasma Spp	Whole area
13.	Heart-water	Tick	Rhicketsia ruminantum)	(WHole area
14.	PPR	-	Viruses	Whole area
15.	Lumpy skin disease	Flies	Viruses	Whole area
16.	Rif Valley Fever	Flies	Viruses	Whole area
17.	Mange	Mite	Parasite (Psorcopts Spp.	Whole cattle / goats /

Source: NCAE, 2018

4.2.9 Deterioration of Rangelands

Analysis of rangeland utilisation by both wildlife and livestock gives a general indication that NCA habitats are undergoing rapid changes, suggesting that livestock productivity is increasingly threatened. Physical and natural resources analysis has shown that pastoralists in the NCA have traditionally utilised the rangelands as part of a communal property regime, and practised transhumance mode of livestock keeping based on the seasonality of resource abundance. Shrinkage of grazing land, which is cause cattle to smaller grazing areas. High grazing pressure in the NCA has induced retrogressive ecological changes, which reduces the primary productivity of rangelands. The limited grazing land has disrupted a traditional pastoral land use system that also maintains the landscape, and which the tourism industry depends on. As a result, livestock diseases and the ultimate failure in productivity are partly associated with restriction of livestock in smaller areas.

The fact that NCA rangeland has already deteriorated due to invasion of both exotic and indigenous plants, water scarcity and recurring dry spells, while also supporting wild herbivores, suggests that the area is already overstocked. Furthermore, livestock composition in the NCA has changed favouring keeping more small stocks, from 6.0% in 1960 to 19.0% in 2017, of total TLUs. In 2017, sheep, whose feeding habits are more destructive to the rangelands, accounted for 60.3% of the total 41,086 TLUs. Research has shown that, on average, drought causes mortality of 30% to 50% of livestock in years of severe dry spells in the NCA (Machange, 1997). In 2017, the death of 77,889 cattle, 78,490 sheep and 72,881 goats, which accounted for 32%, 23% and 32% of livestock populations respectively, in the NCA, was associated with drought (Table 32). Both food security and the affuence of the by the mass death of livestock.

Table 32: Livestock mortality in the NC

No.	Livest	Tooctka l	Poplu	ast oon c% k	Dea att n l i t y
1.	Catle	243,069	77,889	32.04	
2.	Sheep	344,373	78, 490	22.8	
3.	Goats	226,260	72,881	32.2	

Sou NCAE, 2017

4.2.10 Livestock Rustling

Cattle rustling affects the economy and occurs both within and outside the NCA; cattle stolen outside the NCA are taken inside and vice versa. These cases are

common in Osinoni, Esere, Laitole, Endulen, Naspooriong and Oloirobi. The theft of sheep, goats and donkeys is also common in some areas in the NCA. Goats, sheep and donkeys are mostly stolen in Esere, Laitole and Endulen, whereas donkeys are mostly stolen in Kakesio and all areas where cattle rustling is common.

4.3 Conservation Development Challenges

The purpose of preserving biodiversity and cultural heritage resources is to ensure that such values are maintained, and to provide outstanding scenery for tourism, community development and ecology in the area. To a large extent, the purpose of conservation development has been achieved. In relation to the main global indicators, the NCA shares four of them. It is the only conservation area that is a World Heritage Site (WHS), man and biosphere reserve (MAB) and global geopark. No other site in the world shares three UNESCO designations. This is an indicator that the NCA meets global conservation and management standards. However, over the past 60 years the NCA has been faced with challenges that are structural with regard to the multiple use policy. The growth of human uses in the area has continued unabated since 1959, which has had an effect on the conservation of biodiversity in the area as well as preservation of cultural heritage. The growth in human between conservation and human development. And it seems that conservation development is winning at the expense of human development. In order to resolve these confcts, there is a need to from land for conservation through strict zoning. This is the major proposal of the GMP. Specifc conservation development

4.3.1 Declining Water Quantity

Remarkably, there is little information on hydrology, water usage and water quality, in spite of the fact water availability is essential for the management of all resources and human activities in the NCA. There have been many water development projects, but most are currently non-functional. The growing use of water resources by tourist facilities and increasing diversion for domestic use on the Ngorongoro Crater rim have disrupted natural water regimes and patterns, although there is insuffcient da the early 1990s, the NCAA began to address water pollution and conservation within the area and the surrounding region (NEMC, 1994). Investigation of water resources in the NCA, undertaken by BridgIT Water Foundation (2016), revealed that water assets had been diminishing for many years in the Conservation Area, but there are still no planned or viable attempts to arrest this decline. The

investigation also showed that there were no records or engineering/technical reports covering the development, monitoring, testing and growth of the water systems and infrastructure within the Conservation Area. Consequently, the Authority is placed in the rather unique position of having little understanding of its current water resources compared with that in the past. This is particularly vital when the impact of water is being considered on a broader scale; for instance, how it has affected the balance within the crater. There is no common set of standards to control all aspects of water, water projects, water structures, installation requirements or the operation of water related assets across the entire Conservation Area. While access to water for humans and livestock is still critical, the legal status of water is still unclear. Also, unsustainable livestock watering practices (Plate 20) and continuing extraction of underground water (drilling of bore holes) in Karatu and adjacent to the NHFR are posing further threat to water availability in the NCA.

Plate 20: Livestock watering in water sc

Source: Field Data, Date: 30/07/2018, 13

4.3.2 Declining Forest Cover

Forests in the NCA are under considerable pressure from illegal harvesting of building materials and frewood primari boundary (Chamshama et al., 1997; Strukhsaker et al. 1997). Uncontrolled

burning and inadequate control of the NHFR for cattle grazing are other concerns. Vegetation change was measured in 1988, using satellite imagery, and this showed that there was substantial loss of woodland and forest. Most of the forest loss was documented in the eastern part of the NHFR. Woodland destruction is most common north of Lake Eyasi, while bush encroachment has taken place in a number of the more arid areas. Additionally, analysis of land cover maps obtained from satellite images of 2000, 2010 and 2020, have shown a decrease of vegetation cover with part of the NHFR (borders with Longido, Monduli and Karatu), and some forests in the NCA such as Misigiyo, Olmoti and Elerai.

Field visits within the NCA (2018) have discovered ongoing human activities in the forests and the destruction and pollution of water sources. Such activities include livestock watering (for instance, Ndutu masek), the drilling of water wells for livestock and extraction of forest res construction of bomas and livestock cages. Moreover, forest destruction has been observed in the Northern Highland Forest Reserve, Empakai Crater Forest, Elerai Forest and Olmot Forest. Although prohibited, livestock grazing still occurs throughout the year in the Empakai Crater and its forest as well as the NHFR (Plates 21 and 22).

Plate 21: Livestock grazing in the Northe

Source: Field Data, Date: 02/12/2018, 1

Plate 22: Livestock grazing in the Em

Source: Field Data, Date: 02/12/2018,

4.3.3 Expansion of Human Settlements

In spite of the NCA Act, human settlements in the NCA have grown both in size and complexity. This, however, is consistent with the increase in the human population of the NCA, while the size of the area has remained the same since 1959. The increase is creating immense pressure, which has been observed in and along major resource areas such as the NHFR in Irkeepus (Lolesho and Irkeepus hamlets), Loomunyi and Oljoorai settlements in Meshil and Ngoile as well as Ngotootosumbat settlements in Kayeepus established in the Olmot forest. Also, some settlements have been observed along and in the Northern Highland Forest Reserve in Kapenjiro and Nayobi settlements, which poses a threat to the forest and its resources. These settlements are expanding at the expense of the forestland and its resources. Increasing permanent iron sheet structures contradict the idea of a "conservation" area. Therefore, implementation of building codes and structure guidelines is required, which limits permanent and "silver shiny" structures in the NCA.

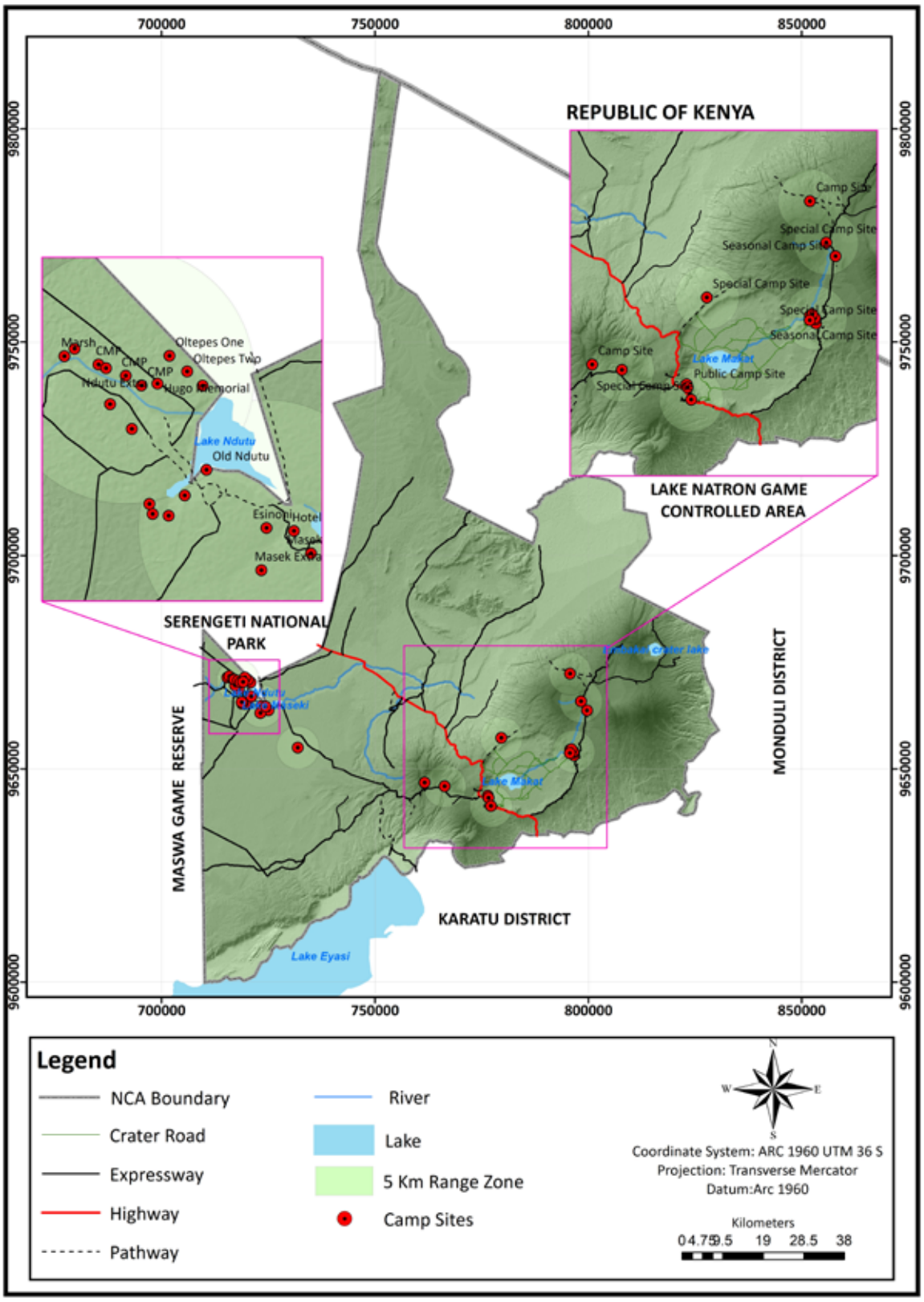
Plate 23: Expansion of setlements towa

Source: Field Data, Date: 02/12/2018, 12

4.3.4 Growing Number of Tourism Facilities

The scenery and environment are important to indigenous residents of the NCA, just as they are to the NCAA and visitors. In village meetings, residents raised concerns about the visual and environmental impacts of the growing number of non-traditional structures. For instance, they emphasised the need for a reduction in lodges in the crater rim and campsites in Ndutu area (Map 25). In Ndutu alone, there are 21 temporary designated campsites, which is detrimental to the environment. Residents expressed a desire to preserve the landscape, while having the option to upgrade their traditional homes. However, the latter still presents a challenge.

Map 25: Distributon of campsites i



4.3.5 Declining Numbers of Wildlife Species

There has been a considerable decline in the numbers of certain wildlife species in the NCA. In fact, reduction in most threatened large mammal in the recent catastrophic throughout Africa. Locally, over 100 rhinos were reported living in Ngorongoro Crater in the late 1960s (Goddard, 1967), declining to 12 in 1995 (Moelhman et al., 1996). However, with increasing security and close monitoring, rhinos increased to 19 in 2003 (FZS, 2003), and above 60 in 2020 (Manongi, 2021, pers.com). Increase in tick-borne diseases and predation of infant rhinos by hyena continue to threaten the rhino population in the Ngorongoro Crater.

Other wildlife species that experienced serious decline over the past 60 years include wild dog, oryx, greater kudu and lion. The crater lions have suffered from a number of severe disease outbreaks over the past 40 years. Although the population recovered exponentially from a severe epizootic in 1963, three outbreaks between 1994 and 2001 occurred in such rapid succession that the population was unable to return to normalcy. The crater population may have become unusually vulnerable to infectious diseases in recent years owing to its proximity to a growing human population and inbreeding (Craig Packer, Personal Comm., 2004). The crater lions may, therefore, provide important insights into the future of many endangered wildlife populations.

Efforts to conserve wildlife in the NCA, which were undertaken between 2008 and 2017, have led to an increase in the wildlife population. Community perceptions is that in the past 10 years some wild species such as elephants, lions, giraffes, buffaloes, wildebeests, leopards, hyenas and zebras have been increasing except in areas such as Masamburai, Olpiro, Kapenjiro, Alchaniomelok, Bulati, Iltulele, Nayobi and Sendui. Wild dogs, rhinos and cheetah are the only species which have signifcantly decreased in the species and their distribution in the NCA is the result of illegal hunting (especially in settlements bordering villages in Karatu district), increased human activities, wildlife diseases (livestock transmitted diseases), drought, corridor blockade and invasive plants.

4.3.6 Poaching Incidences

Illegal utilisation of natural resources in the NCA poses a challenge as it does in many other conservation areas. The main poaching activities are logging for timber and poles and hunting animals for meat and trophy. Hunting is mainly for subsistence and small-scale commerce. It is mostly non-NCA residents on the periphery of the Northern Highland Forest Reserve (NHFR) who carry

out logging and illegal killing of wildlife. In the period between July 2000 and December 2004, poaching activities were recorded inside and adjacent to the Conservation Area (in the forest reserve). Between 2012 and 2018, a total of 34 poaching cases in the NCA involving 67 people were recorded as shown in Table 33.

Table 33: Poaching cases in the

No.	Year	Number of Poaching Cases	Number of Persons Involved / Charged
1.	2012	2	3
2.	2013	6	9
3.	2014	2	5
4.	2015	4	7
5.	2016	2	4
6.	2017	7	19
7.	2018	11	20
	Total	**34**	**67**

Source: NCAA, 2019

Tree species heavily poached are African Olive (*Olea africana*), Sandal Wood (*Osyris abyssinica*), Greentour (*Fagaropsis angolensis*) and Croton (*Croton megalocarpus*). Animal species that are mostly poached include elephants and dikdik for tusks and meat respectively. Illegal hunting of dikdik and other small animals is still evident mostly in areas (Olpiro) bordering villages of Karatu Districts. It is recommended communities establish ranger posts in all areas bordering villages outside the NCA. Also, the NCA needs to work with relevant authorities in order to restrict hunting of wild animals adjacent to the NCA as well as involve indigenous people to protect resource values.

4.3.7 Exotic and Invasive Species

Introduction of both exotic animals and plants may have a far-reaching effect on native species and the ecosystem as a whole. The main concern with regard to animals is the introduction – prior to camels in Olbalbal, found in areas surrounding Malanja. In addition, invasive alien species pose a real and signifcant t areas. This is viewed as the second greatest threat to global biodiversity (Cronk, 1995). The main focus of control in the NCA has been the crater and on Thorn apple (*Datura stramoniun*) and Mexicana poppy (*Argemone mexicana*).

A study undertaken by Marau Taiko Salei and Frank Mawi, in 2008, revealed that 2058 individual *Datura stramonium* were counted in different habitats such as open grassland, bushland and woodland in the NCA. In areas invaded by unpalatable plant species, *Datura stramonium* could dominate other plant species in the area. The *Datura stramonium* are mostly dispersed to different areas by goats, which feed on apples, fow rivers, birds and other animal movements from one place to another. The most common invasive plant species in the NCA are Esirondet, Olosida kutuk, Alaimererwani (Mbigiri), Alaisikirai, Endamejoi/ Washawasha, Oldule and Arpaliki/Datura plants.

Increasing invasive species in the NCA have serious negative effect on livestock and wild animals such as suppressing pastures and causing death. However, little has been done to document and mitigate the increasing threats posed by alien plants in general. There is also a connection between spread of invasive species and extensive grazing and browsing by livestock in the area. Studies show that areas that are heavily grazed or browsed by livestock have the most invasive species and vice versa.

4.3.8 Perceived Inbreeding

Small populations face threats of genetic and demographic health, in particular when their effective population size is small and the animals are isolated (Moelhman et al., 1996). The combined factors, which include slow population growth due to density-dependent social interactions, high levels of inbreeding and a variety of stochastic factors such as demographic shifts and diseases, means that animals are extremely vulnerable. There are great concerns that the slow population growth rates of the rhinos and lions in the crater could be the result of isolation and inbreeding problems. This theory encouraged further research, and, in 2012, Craig Parker of the University of Minnesota, associated the low population of lions (52) in the crater, which was below the carrying capacity (100), with inbreeding problems, leading to compromised resilience to diseases and impaired reproduction. However, further study is needed to establish the inbreeding coeffcient of cra pattern within the NCA, and to establish the genetic status of lions in Ngorongoro Crater.

4.3.9 Blockage of Wildlife Movement Routes

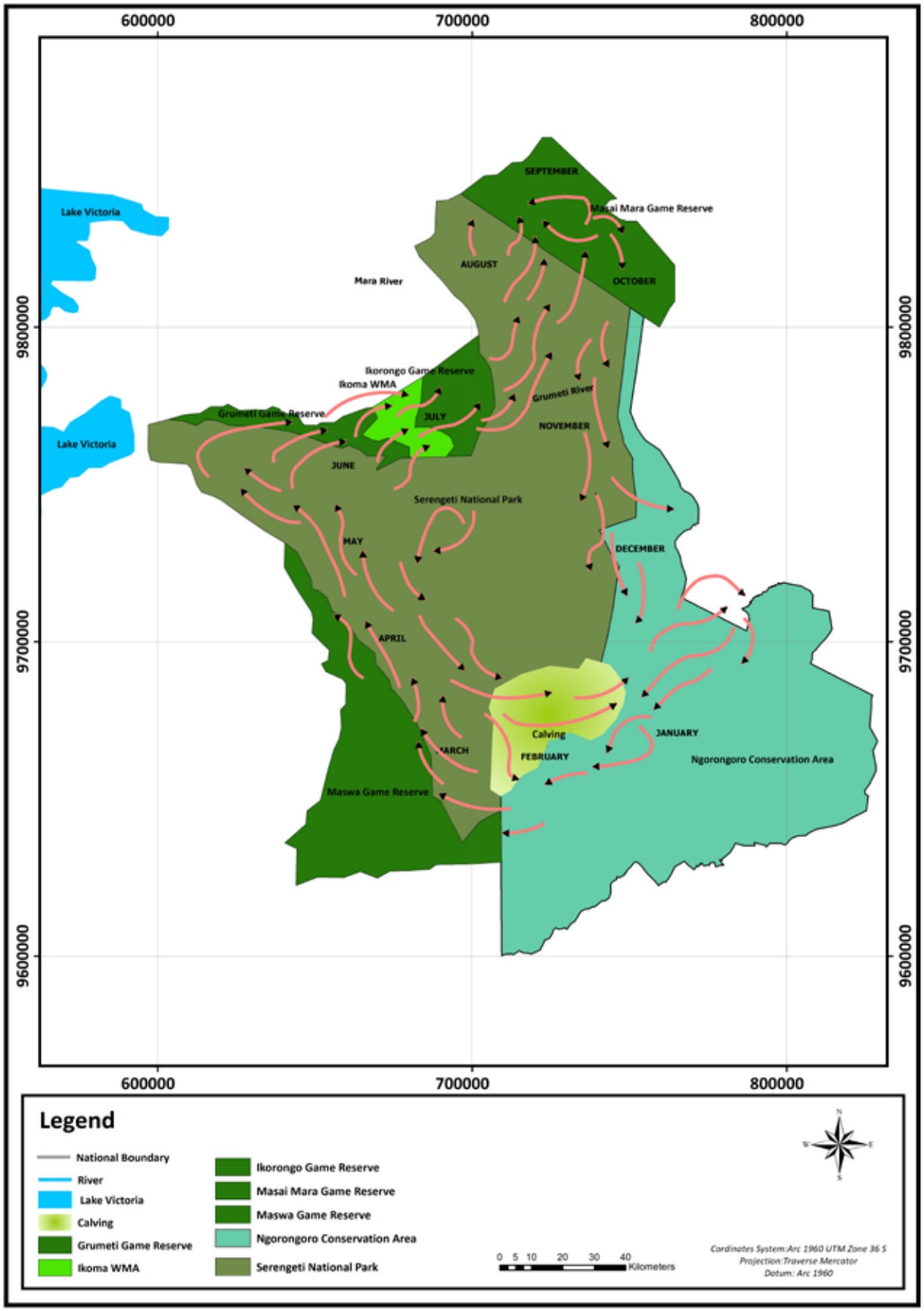
It is well known that the Serengeti and Sale Plains within the NCA play an important role in the annual migration of wildebeest in the Serengeti ecosystem (Map 26). The plains in the NCA also serve as the primary calving area for

migrating wildebeest. Other wildlife movements within the NCA have been little studied beyond the Ngorongoro Crater. Discussions with NCAA staff and NCA indigenous residents indicated that there is a network of trails and corridors linking the highland forests and Ngorongoro Crater with the Serengeti Plains. On the plains certain places appear to be important nodes for wildlife, such as the Olbalbal Depression and the Ndutu area. Important habitats also include microenvironments such as springs, wetlands and kopjes.

Further corridors link the NCA to other protected areas. To the east, the Kitete corridor has historically connected the NCA to the area that is now Lake Manyara National Park, and to the south another route passing near Endamaghay and known as Laja connects the NCA to Mang'ola Forest. This corridor extends to Lake Manyara National Park through Marang Forest. The continued viability of these corridors is unclear. To the west there is open movement of wildlife into the Maswa Game Reserve. The annual migration of wildebeest and other plains animals depends on free movement to the north into Serengeti National Park and the Loliondo Game Controlled Area. A regional orientation, therefore, is imperative for the management of these corridors. It is essential that all corridors and important habitats remain open and available for wildlife. Some human uses such as livestock grazing are compatible with wildlife movements, while others including tourism development, settlement and cultivation can be disruptive and must be avoided (Runyoro, 1994).

In the NCA, land use changes have transformed land cover to livestock grazing lands and human settlements at the expense of wildlife habitat. These changes are associated with wildlife losses, habitat destruction, land degradation and blockage of wildlife corridors. Usually, wild ungulates avoid urban and settled areas (Nyamasyo and Kihima, 2014). A wild corridor linking the Ngorongoro Crater and Loliondo Game Controlled Area has been blocked due to human activities in Ngototoosumbat and Ndepes hamlet in Kayepuus settlements. Also, a corridor linking Ndutu plains and Rift Valley Escarpment is blocked by the presence of human settlements between Alaitole and Osinoni (Field Data, 2018).

Map 26: Wildebeest migratory routes and c



4.3.10. Extraction of Raw Materials from the NCA

The legal protection accorded to the NCA from commercial mining is unclear. There is a provision in the Mining Act 2010 that restricts rights of entry of a holder of a mineral right to an area declared a reserved area or a protected monument by the Antiquities Act. However, in the NCA, illegal harvesting of forest products continues in the highland forests, and extraction of gravels, sands, stones, bamboo and other forest resources (wood, poles, medicines and frewood) is still evident in most area and inconsistent enforcement. Field surveys (2018) have shown that the NCAA and the communities themselves (both within and adjacent to the NCA) are the main harvesters of raw materials followed by hotels and campsites owners as well as social service institutions such as schools and dispensaries. Forest resources are mostly extracted followed by gravels and murram. These materials are being extracted within the NCA and adjacent areas to meet human and tourism development needs without proper regard for scenic and environmental consequences. However, since environmental issues are cross-cutting in nature, whenever there is any contradiction, the Environmental Management Act (EMA), 2004, has provided for its preeminence to all laws.

Plate 24: Harvestng of forest products

Source: GMP: 2006 – 2016

4.3.11. Soil Erosion

Erosion is a natural process, but it may be unnaturally accelerated by uncontrolled human activities. In the NCA, human-caused erosion that tends to be localised, rather than widespread (Perkin, 1993), has been linked to off-road driving, poorly designed or maintained roads, extraction of materials (sand, gravels and murram), wildfres and improper grazing pat Changes in weather, in particular rainfall trends, winds and unavailability of enough water supplies have led to the concentration of livestock and wildlife for longer periods and, therefore, soil erosion (livestock trampling).

Table 34: Areas mostly afected by soi

No.	Name of Se	Mtolsetmleyn t	Afected Areas
1.	Osinoni		Ngereyani, Naishu – Ngiri
2.	Esere		Ololchani - Olosaunya, Orkur
3.	Laitole		Ololoitkosh – Ololehani
4.	Endulen		Embaruai road, Hospital Road Madukani, Oltogom, Mutanie
5.	Naspoorion	Ngi	iani
6.	Loongojook		Longooku, Crater way, Misigiy
7.	Meshelii		Olbalbal
8.	Ngoile		Ngolola, Ngoile, Olchurai
9.	Olpiro		Sawacheka
10.	Alchaniomelok		Kiragarien
11.	Sendui		Osirandet

Sou Fiedde Data, 2018

4.3.12. Pollution and Littering

In the early 1990s, the NCAA began to address the challenge of air and water pollution and the disposal of solid wast surveys undertaken in different areas in the NCA, between June and August 2018, have shown the existence of pollution (soil, water and air) as another form of environmental degradation (apart from soil erosion), which results from littering, poor waste disposal and extraction of materials. More community awareness programmes on environmental management are required to ensure high personal hygiene, and to emphasise to the community the importance of building and using household toilets, prohibiting extraction of materials (especially gravels, murram and sand) and improving waste disposal within the community and from lodges and campsites. A for controlling improper waste disposal in the NCA is banning the use of lunch

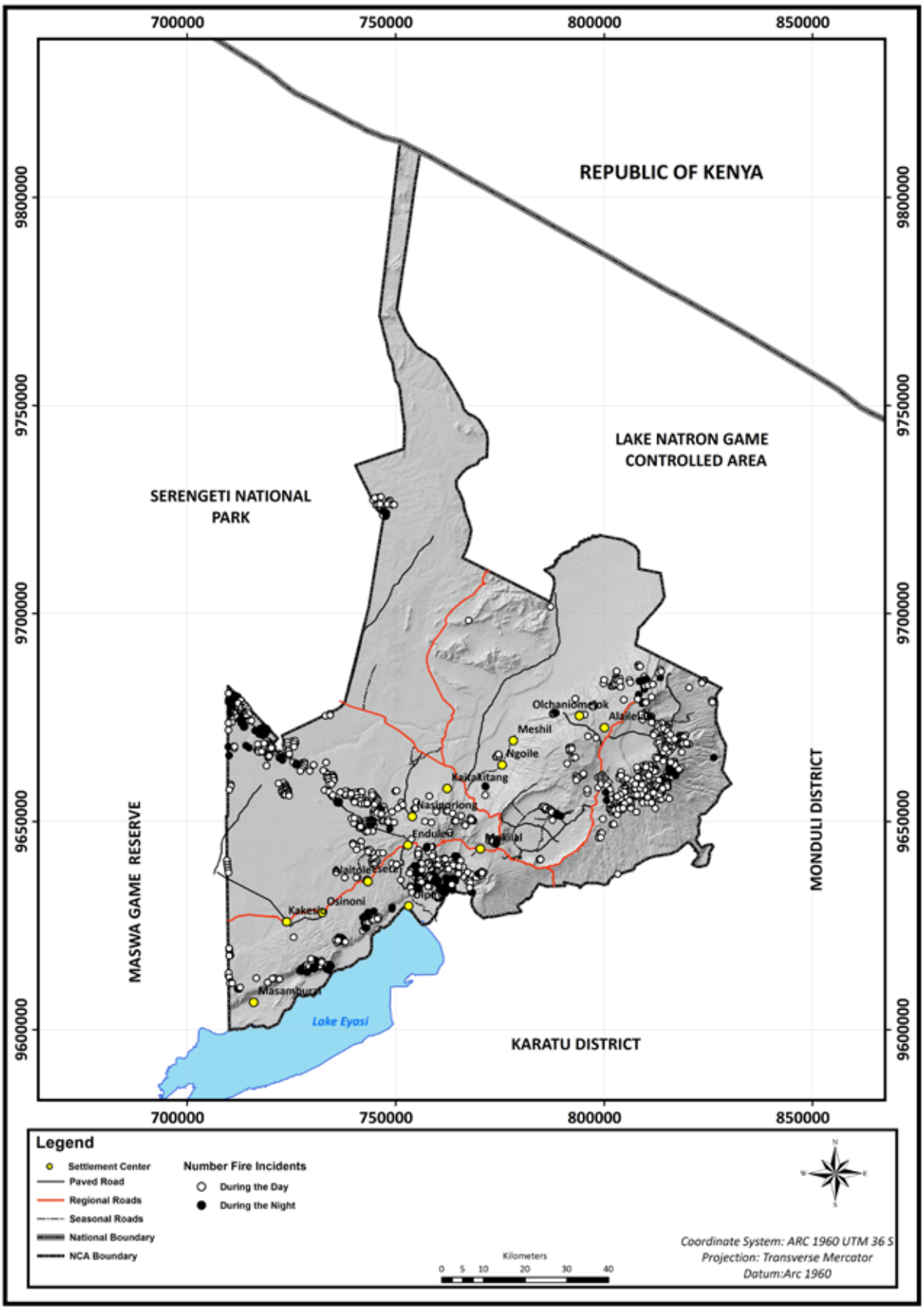
boxes by tourists. Instead, the NCAA needs to establish hot meals centres or cafes to enable provision of lunch. For instance, a café for providing lunch to tourists near SENAPA boundary is important for minimising or eliminating improper disposal of waste (leftovers, tissue papers and paper bags).

4.3.13. Wildfires

For a number of years, wildfires have been
Nainokanoka and Ngorongoro wards and the Northern Highland Forest Reserve. Beekeeping, which is one of the major economic activities of some members of the community in the NCA and areas adjacent to it, plays an important causative
role in wildfires. For instance, Osinoni, K
have had wildfires caused by inappropriate
Moreover, in Alchaniomelok and Sendui, there have been recent cases of
wildfire due to the creation of new pastur
pasture when rains set in and to control
to honey gatherers and animal hunters, particularly in the Northern Highland
Forest Reserve. Unplanned fires have a grea
area.

The high concentration of herbivores on burnt areas to forage for new tender grasses leads, in most cases, to the trampling of the sites. This may result in the disappearance of some important plant species and micro-organisms. Sometimes, following changes in vegetation composition, the habitats of other
creatures such as ground nesting birds may
and frequency of burning. Occurrence of fr
result in over burning leaving the land bare and vulnerable to invader plants and soil erosion. In view of these concerns, there is a need for permanent solutions before the problem gets out of hand both environmentally and ecologically. Communities should be trained in sustainable and environmentally-friendly methods of beekeeping and harvesting of honey.

Map 27: Fire incidents in the NCA



4.3.14 Changing Cultural Values

Traditionally, residents in the Ngorongoro Conservation Area, especially the Maasai, live in homesteads consisting of a large circular enclosure surrounded by thorn bush fences (bomas). The size of the bomas depends on the number of household members. Houses are rectangular with slightly domed roof. They are made with poles and saplings, intertwined with grass and plastered with cow dung. The Maasai, who are pure pastoralists, rely on livestock for food and income, while the Hadzabe (living in Lake Eyasi basin) practise hunting and gathering as their means of livelihood. The Datoga people, who are mainly agro-pastoralists, depend on livestock and crop farming for their livelihood. In the NCA, the Datoga are found in Olpiro and Masamburai areas.

As in other parts of Tanzania, the cultural values of residents of the NCA are changing due to increasing interaction with other communities, livelihood diversifcation caused by economic hardshi
services as well as advancing communication technologies. Cultural dynamics in the NCA have led to changes in residents' lifestyles in terms of food consumption, housing and economic activities. For instance, since its establishment the NCA has witnessed changes in construction from traditional to modern houses made of permanent building materials such as cement blocks and bricks and roofed with corrugated iron sheets. The increasing number of modern houses does not blend in with the natural environment, thus affecting the aesthetic value of the area.

Plate 25: Past and current housing stru

Source: NCAA, 2019

Changes in the food consumption of the NCA community is attributed to declining per capita TLU, climate change and population increase. This forces residents to resort to other sources of food apart from the traditional diet of meat, milk, blood, fruits, herbs and roots. Some of these sources, for instance, wildlife

hunting (illegal hunting and poaching) and crop cultivation, are detrimental to the conservation of resources. This is evidenced by increasing cases of illegal hunting and poaching and crop cultivation in some parts of the NCA.

Plate 26: Illegal cultvaton in Nayob

Source: NCAA, 2018

In line with changing food consumption, the NCA community, especially the Maasai, are now engaging in different economic activities to obtain income. Such economic activities, including small business and trade, employment, beekeeping, charcoal burning and frewood c community, are also detrimental to conservation and tourism. Small businesses and trade involve the introduction of commodities in the NCA, which leads to environmental pollution and emergence of invasive plant species, pest and disease. With increasing employment opportunities, many people with different cultural values are attracted to migrate and settle in the NCA, thus contributing to its changing cultural values. Improper beekeeping, charcoal burning and frewood collection methods have been the forest species in the NCA.

As culture is not static, NCA community cultural values will continue to change due to social, economic, technological and environmental conditions as described above. Thus, the ways in which cultural values change will affect resource conservation in the NCA, which rejects the paradigm that the NCA communities are the primary conservators of resources.

4.4 Visitor Management and Development Challenges

The main purpose of management of tourism is to optimise visitor enjoyment and safety and minimise the adverse effects of tourism and visitors on the NCA and its resources. Visitor management refers to any intervention at the destination or tourism product levels that infuence vi place or attraction. Tourism in the NCA is booming leading to a considerable

increase in revenues. The highest amount of revenue collected in the NCA reached TZS 143.5 billion (US$ 61,664.51) which means this conservation area earns the highest revenue per unit area, more than any protected area in Africa. However, there are still shortcomings and environmental issues, as highlighted below.

4.4.1 Congestion of Vehicles in the Ngorongoro Crater

The number of vehicles entering the crater through both Lemala and Seneto routes has increased remarkably since 1997. Visitor attractions inside the crater have remained the same. Increase in the number of vehicles creates congestion of tourists and vehicles at a few visitor attractions. Interviews with tour operators, hotel owners and the Safari Guides Association indicated that most visitors still complain about too many vehicles inside the crater. Vehicle congestion reduces visitor enjoyment and and other environmental impacts in the NCA in general. During high season, between June and October, it is common to see between 100 and 270 vehicles a day in the crater and an average of 70 vehicles during low season. Often, 20 or more vehicles line the road at a wildlife event. Most tour vehicles in the crater carry only a few passengers well below their capacity. However, despite this challenge, no signifcant control measure i and to allow only a certain number of vehicles to enter the crater at a particular time each day. The increasing vehicle congestion implies that the number of visitors to the NCA continues to grow.

Plate 27: Vehicles congeston in the Ngor

Source: NCAA, 2018

4.4.2 Narrow Range of Tourists to the NCA

Despite the increasing number of tourists to the NCA, its resource values and tourism potential are still not widely known by the majority of potential visitors from around the world. The NCA can attract more than 1 million tourists per year, if they are widely and evenly distributed in the reserve. Data obtained from the tourism division indicates that most visitors to the NCA come from the USA, United Kingdom and Germany (NCAA, 2003). There are few tourists from Japan, East Africa, South America, China and South East Asia. This has been due to lack of knowledge of what the NCA offers in terms of tourism. The NCAA does not have a proper marketing strategy, and thus fails to collaborate adequately with other stakeholders such as the TTB, TANAPA, Tour Operators Association of Tanzania, Air Tanzania Company Limited and many others to promote tourism in the area. Although there are ongoing efforts to collaborate with stakeholders to promote tourism, the NCAA needs to implement a new product development strategy, which will enable the NCA to attract more tourists by offering various products.

4.4.3 Inadequate Tourism Services in the NCA

Information and interpretative materials are an important means of stimulating visitors' interests and promoting understanding of a protected area, thus making the visit more enjoyable and instilling a sense of responsibility for conservation. Many of the NCA's significant problems, fo directly to a lack of understanding and responsibility. In this regard, the presence of guiding services, interpreters and other visitor services such as maps showing locations of different sites in the NCA are important.

However, the absence of adequate education materials means that most visitors to the NCA receive little information about the area, its resources and values. There are inadequate visitor contact areas, interpretation facilities or exhibits along the major routes of the NCA or at NCAA headquarters. Also, resources for supplying information about the NCA and NCAA regulations, maps of game viewing circuits and the status of various are still inadequate. There is little written information about NCA resources and NCAA regulations available to tourists. No information services are provided to make tour guides and operators aware of NCA conditions, animal locations, or road status. The NCAA guides are few and inadequate for visitors. In addition, tour guide materials provided by private drivers are of very low quality.

The visitor contact station at the Lodoare entrance gate has been improved, but it is still very small to accommodate many tourists and their vehicles especially

during high season. There are a number of shabby taxidermy exhibits, and no modern interactive and interpretative approaches to stimulate visitor understanding and appreciation of NCA resources. The visitor experience in the NCA is limited to driving along an extensive system of two-way roads and inside the crater, which is always congested by visitors. There is no on-site interpretation and few opportunities for visitors to get out of their vehicles in many parts of the NCA. Thus, the NCAA needs to expand the tourist circuit by improving roads and promoting other sites in the southwest of the area (Masamburai, Endulen and Kakesio).

4.4.4 Shortage of Accommodation in the NCA

During the high season the number of non-resident tourists entering the NCA per day supersedes the number of beds available for accommodation. For instance, in July 2017, the number of non-resident tourists entering the NCA was 50,527, an average of 1,684 tourists per day. Howe (165 beds), Ngorongoro Crater Lodge (60 beds), Wildlife Lodge (150 beds), Rhino Lodge (60 beds) and Sopa Lodge (186 high number of visitors during high season (Table 35). Due to increasing tourism in the NCA in recent years, all these accommodations are almost fully booked throughout the year.

Most non-resident visitors prefer to spend their night in the NCA and to complete their programme of visits. However, due to congestion and limited accommodation, they spend a few days to avoid long travel in and out the NCA, which is also tiring because of the standard of roads. Even if campsites in Ndutu area are used during the high season, they cannot absorb the high number of visitors preferring to spend their nights in the NCA.

Table 35: Number of non-resident vis

Season	Month	Years							
		2010	2011	2012	2013	2014	2015	2016	2017
Low season	April	9,618	13,981	14,073	11,337	13,314	10,325	11,379	14,318
	May	11,995	12,536	14,620	15,728	14,328	12,261	13,453	15,391
High season	July	38,583	44,519	44,334	47,529	48,329	38,878	42,936	50,527
	August	40,007	45,462	45,536	46,488	41,885	36,165	46,422	48,756
	September	25,804	29,345	29,408	30,996	29,318	25,138	29,684	31,325
	October	26,278	33,345	21,045	33,115	34,037	25,233	44,656	34,559

Source: NCAA, 2018

Adding more accommodation in other parts of the NCA can help to increase the number of nights and reduce congestion in the already existing facilities/lodges.

The NCAA through its tourism product development plan can encourage private sectors to establish overnight facilities (standard accommodation and other luxury facilities) in Karatu, Babati and other areas adjacent to the NCA.

4.4.5 Inadequate Tourism Facilities

Other existing tourism facilities and infrastructure such as roads, walking trails, picnic sites, stopovers and toilets do not cater to the needs of tourists in the NCA. Access roads towards potential tourism sites are inadequate. Furthermore, the absence of picnic and camping sites and access roads in some parts of the NCA hinders the provision of adequate visitor experience. For instance, over the years, campsites located near Ndutu and Masek lakes have aimed at accommodating groups interested in viewing the annual wildebeest migration, which is normally from January through March. There is little control over use in the area, and a network of unplanned tracks is evident in the area because access roads to the sites have not been clearly marked.

As tourists are increasingly seeking to explore remote places, several tour companies are offering short hikes and walking safaris in the NCA. Although to date there are several walking safaris campsites, and designated stopovers in the NCA are in operation, more walking trails and stopovers are required in order to provide visitors with enough experience of walking and exploring in areas of natural beauty.

4.4.6 Poor Road Networks and Road Condition in the NCA

Roads have been slowly deteriorating since the NCA was established, and consistent with the evolution of attractions. Tour operators in the area, who designated most of the roads, complain of their poor condition, and that the existing road networks do not meet their r
the maintenance of vehicles. The congestion of tourists at few attractions is also the result of poor networks or road conditions.

CHAPTER FIVE: DESIRED FUTURE CONDITIONS AND MANAGEMENT ZONES

5.1 Desired Future Conditions for the NCA

In view of the main challenges affecting the existing purpose, the following conditions are necessary for ensuring that the NCA are preserved:

a) Prevent human, wildlife and livestock co

b) Eliminate zoonotic diseases.

c) Improve tourist satisfaction, visitor experience and access to biodiversity and cultural heritage resources.

d) Free the outstanding resources from degradation (erosion, pollution, deforestation) and its drivers. This condition will allow preservation of the outstanding resource values of the NCA, and promotion of tourism development in the area.

5.1.1 Management Objectives

Based on the desired future aspirations of the NCA, the key management objectives are as follows:

a) To ensure preservation of the landscape and its resources.

b) To improve tourists' satisfaction, experience and access to biodiversity and cultural heritage resources.

c) To ensure preservation of cultural heritage resources.

5.1.2 Future Purpose of the NCA

The future purpose of the NCA is based on the need to preserve the landscape and its resources to improve tourists' satisfaction and experience. Thus, the purpose is ***to restore degraded areas, conserve biodiversity, preserve cultural heritage resources and promote tourism development in the NCA.***

5.1.3 Vision and Mission

The desired vision of the NCAA is "***to become one of the best conservation area in the world*"**, whereas its mission will be ***to preserve biodiversity, cultural and geo-heritage resources of the NCA for optimal visitor experience and satisfaction through improved visitor interpretation, infrastructure and safety.***

5.2 Management Zones

Management zoning is a planning technique used for evaluating and classifying protected areas. The management zoning scheme of the NCA designates where various management strategies will best resolve existing challenges facing the conservation area, protect outstanding resource values and accomplish management objectives by defning condition

5.2.1 Development of NCA Management Zones

NCA management zones were developed based on the need to address the existing management challenges and to achieve the desired future conditions of the area. Different criteria were developed to guide designations of the NCA management zones:

a) Practically manageable zoning scheme;
b) Introduction of uses and physical developments that minimise existing management problems;
c) Elimination of uses and physical developments that damage natural and cultural assets;
d) Protection and enhancement of the outstanding natural and cultural values or assets;
e) Constraints imposed by landscape and ecological determinants;
f) Provision of a diverse range of appropriate visitor experiences.

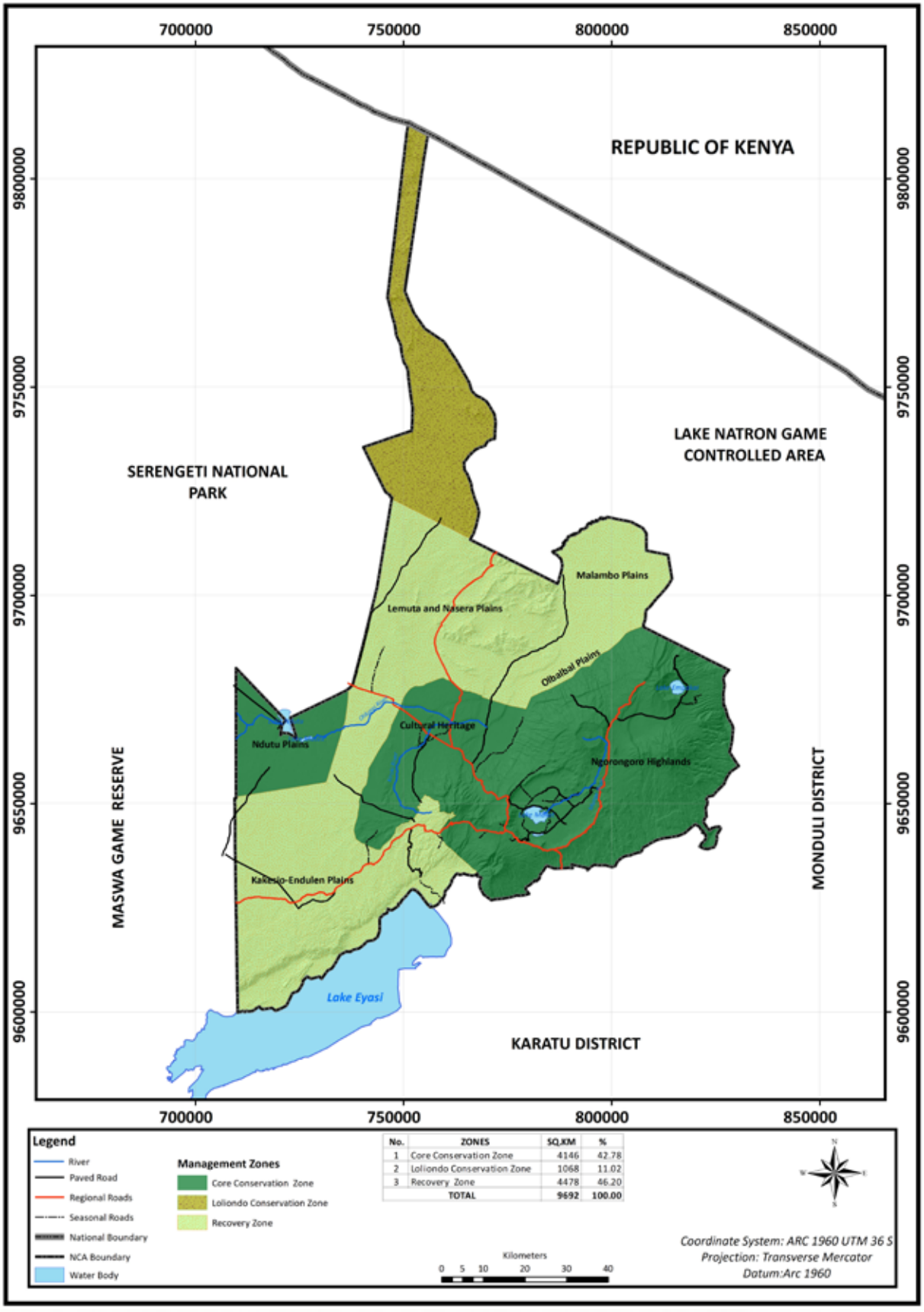
5.2.2 Management Zones of the NCA

Based on the above criteria, three management zones were designated, namely, the Core Conservation Zone, Recovery Zone and Loliondo Conservation Zone (Table 36 and Map 28).

Table 36: NCA management zones

No.	Management Zones	Area (Km^2)	Percentage
1.	Core Conservation Zone	4,146	42.8
2.	Loliondo Conservation Zone	1,068	11
3.	Recovery Zone	4,478	46.2
Total		**9,692**	**100**

Map 28: NCA management zones



5.3 Description of Management Zones

5.3.1 Core Conservation Zone

The core conservation zone has a total area of 4,146 square kilometres and is divided into three sub-zones: Ngorongoro Highlands, Cultural heritage (Oldupai and Laetole) and Ndutu plains. Further descriptions of these sub-zones are presented below.

5.3.1.1 Ngorongoro Highlands Sub Zone

This sub-zone has an area of 3,023 square kilometres covering the Northern Highland Forest Reserve, craters (Ngorongoro, Olmot and Empakai), Irkeepus, Nainokanoka, Bulati, Sendui, Iltulele, Nayobi, Alailelai, Alchaniomelok, Olbalbal (Ngoile and Meshil), Kaitakiteng and Kapenjiro. It also covers Mokilal, Keyapus, Misigiyo, Loongojook and Oloirobi areas. Engaruka historical site and Selela village forest reserve, which have been annexed to the NCA, form part of this sub-zone. Further description of this zone, its rationale and allowable uses and limits are shown in the following table.

Aspect of the Zone	Zone Descripton, Allowable Uses
Rationale for the zone	Catchment area: Forest: biodiversity h and cultural sites, botanical value, sequestraton to mitgate climate change supportng the ground water forests in provides water (streams and rivers) fo NCA. Ngorongo: Referred to as the 'Garden of Eden' due to its dazzling beauty, and a paradise for animals, a which is in high demand from visitors NCA where hippos are found. Olmot Crater: Unique character and geologica tourism. It is the source of the Mung Crater with fresh water. Also, the fr the Munge River is vital for wild ani use for Irkeepus and Nainokanoka setle Empakai: Crater supports an abundant variety including bufalo, waterbuck, bushbuck and famingos (breeding site for the l

Resource values	Catchment Characteristics: Catchment Forest, marshes, and fauna), mountains, traditonal me landscape. Ngorongo Crater: High density and greatest biodiversity of wildlife, visible populaton of birds (famingos) and ani zebras and elephants, residents' spir Olmot CBA: Biodiversity, source of springs as residents' ritual and cultural sites. Empakai: Presence of deep blackish wat forests, biodiversity including famin the most important tourist atractons.
Management emphasis	• Relocaton of setlements and the NCAA • Protecton of water catchment as wel fauna species. • To maintain values of the craters, t fauna species, water bodies (swamps • To regulate human actvites in order significance of the area. • Restoraton of degraded areas.
Special protecton areas	Wildlife species, forests (NHFR, Eler trees, endemic Bamboo trees on Oldean mountains, water sources areas (Ngoit swamp, Gorigor swamp and Munge River) Crater.

Permited Uses	Uses	Limits of Acceptable Use
	Tourism	Existing Lodges: Ngoro Ngoro Sopa Lodge, Serena Lodge, Ngorongoro Crater Lodge, Wildlife Lodge.
		Permanent Tented Lodges: Lake Natron (Nasiwt) Naibatat Site B, Empakai Site Site, Makarot Site A, Makarot Ndogolo site, Rhota Glade sit site, Irkeepus site, Ngototosu Nyat Picnic site, NCAA HQ site approximately 1 kilometre from Lodge and Ndogoro site.
		Semi-Permanent Camps: Arusha 2, Tarangire Tembo B, Lemala Extra, Ndepesi, Alch
		Public Campsites: Lemala
		Special Camp Sites: Ciamp Sites: B, Nyat, Lemala Lemala Research Camp, Empakai, 2, Ole Kamwanga, Loongojook, A Bulat.
		Picnic Sites: Sites allowed including Ng Ngoitoktok (Public), Elerai (Seneto, Soito-Naaudo (Special) Mit Mitatu (Special).
		New Picnic Sites: One picnic site to be Empakai Crater rim.
		Hostels: NPC Hostel at Mokilal.
		Ranger Posts and Gates: Olbalbal, existing Olbalbal and any other accordi
		Walking Trails: Allowed through Crater Rim Wal designated areas/routes.
		Game Drives: Allowable number of vehicles according to the site and NCAA regulaton
		Mountain Biking: Allowed in designated areas and undertaken in accordance with
		Cable Car: On the rim of the Empakai
		Stopovers / Hotels: Allowed in designated areas.

	Administration and facilities	• Existng/new ranger posts at c • Existng or new centres/facil need.
	Commercial photography	• Special permit required. • Number of companies and vehic tme to be determined by NCAA
Specifically prohibited uses	livestock grazing, extracton of raw ma	
Other applicable conditons	• Existng lodges and campsites to be Audit. • All lodges to be subjected to an Envi Impact Assessment (CHIA). • Toilets at Ngoitoktok picnic site ar reallocated to avoid/control fecal s the Ngoitoktok springs/swamp and Sen	
	Regulatons outlined on the ofcial rec crater.	
	All other vehicle colours allowed exce	

5.3.1.2. Cultural Heritage (Oldupai and Laetole) Sub-Zone

This sub-zone has a total area of 600 square kilometres and covers the Oldupai Gorge and Laetole footprint areas. Further description of this sub-zone, its rationale and allowable uses and limits are presented in the following table.

Aspect of the Sub Zone	Detailed Descripton of the Sub
Ratonale for the zone	Important landmark for paleontologica tourism atracton, site for the earlie technology, signifcant site for study
Resource values	Oldupai Gorge, post-cranial bones, ja ancestor, human footprints, bird foot river.
Management emphasis	• Preservaton of paleontological and a • Control soil erosion along Alaitole • Protecton of Oldupai Gorge area, Old

Aspect of the Sub Zone	Detailed Descripton of the Sub	
Special protecton	Oldupai Gorge, Oldupai and Kiloki riv numaarne asfootprints, animal and birds' areas.	
Permited	Tyupseess of Us	Limeits of Acceptable Use
	Tourism	Existng OLloddugpeasi: Lodge (Mount Safari Club).
		Hot MAetahelmuseums.
		Museum Alaetoli, Oldupai.
		Walking Safathies museum and f areas.
		Ballooning Allowed in designated areas and undertaken as per NCAA regul
	Commercial photography	Special permit required.
	Research	No Limits but undertaken wit NCAA.
	Administr facilite	Cutbnuraand heritage ofces, ra sresearch centre.
Specifca prohibited uses	Game driving in the sites.	
Other applicab conditon	Vehicles are not allowed on the site Oledupai Gorge).	
	Any constructon or expansion of exi museum) to be subject to EIA, Cultur (CHIA) and applicable legislatons.	
	All lodges to be subject to an Envir Impact Assessment (CHIA).	

5.3.3.3 Ndutu Plains Sub – Zone

This sub-zone has an area of 523Km^2 spanning from Nabi Gate in the north towards Naibatati (Matiti) hills in the south. It borders Serengeti National Park on the northern and western sides. This sub-zone also covers Masek lake and springs, Ndutu marshes and Ndutu grassland plains, which are important dispersal areas for wild animals. Further description of this sub-zone, its rationale and allowable uses and limits are shown in the following table.

Aspect of the Zone	Sub-Detailed Description of the Z	
Ratonale zone	fEocro ltohgeically fragile area (wetlands area for wildlife, suitable gaming dry season, migratory route in the and tourism atractons (beautful lan	
Resource values	Marshes, rangelands, Masek lake and	
Managemen t emphasis	• Protecton of Ndutu marshes, Masek • Conser vAactaotnio aofforestlandsangelands.	
Special pr areas	Nodtuetcutonmarshes, Masek lake and sprin	
Permited	uTsyepse s	oLfimUistes of Acceptable Use
	Tourism	Existng Ndutu Safari Lodge, Tanganyika Wilderness Camp. Permanent Tente Lodk Leo dMgaesse k(.Site Special Camp sNdutu 1, Ndutu 2, Ndutu 3, Ndutu 4, Ndutu 5, Ndutu 6, Ndutu 7, Ndutu 8, Ndutu 9, Ndutu 10, Memorial, Masek, Marsh, Smal Osinoni, Oltepesi 1, Oltepes Mbweha, Ndutu Acacia 1, Ndut Acacia 3, Ndutu Acacia 4.
		Game driving, ballooning.
	Commercial photography	Special permit required.
	Research	No Limits but undertaken wit TAWIRI and NCAA.
Specifcal prohibited	lEystablishment of new lodges and cam d uses	
Other app conditons	lOifc arbolaed driving is prohibited.	
	Any other actvites under ofcial per	
	All temporal tented camps to be sub	

5.3.2. Recovery Zone

This zone covers a total area of 4,478 Km^2 and extends from west of Kakesio to Ndutu, Oldonyo Gol Mountains, Lemuta, Sanjan and Malambo plains. It alo covers Eyasi basin area, Enduleni, Kakesio and Alaitole. The recovery zone

is characterised by the high density of fo
water sources such as rivers and dams. This zone is also the habitat of wildlife and an important migratory route and dispersal area for the Serengeti-Masai Mara ecosystem. Some areas in this zone are prime calving sites (Ndutu, Ang'atakti, Lemuta and Sanjan plains) for wildebeest during wet season. Further description of the zone, its rationale and allowable uses and limits are presented in the table below.

Aspect of the Zone	Detailed Descripton of the Z	
Ratonale of the zone	Flora and fauna species (short gras resources, breeding site for vultures, migratory route for wildlife, spectacular geological formaton, ev materials/paints, Irkarian gorge ar	
Resource values	Rangeland, water sources, Irkarian Nasera rock, Shifing Sand, diversit	
Management emphasis	a) Protecton of water sources. b) Control of invasive species. c) Restoraton and rehabilitaton of d	
Special protecton areas	Water sources, Irkarian gorge, Oldo Shifing Sand, rif valley escarpeme paints.	
Uses	Types of Uses	Limits of Acceptable Use
	Tourism	Existng Lodges: International Agency. Permanent Tented Camps: Olkarian Gorge, Olkarien Gorge B, Lemuta H Kakesio (Kisile), Esirwa, N Special Campsites: Nasera Kakesio 1, Kakesio 2, Kakesio 3, Endulen, Ubuntu, Kasala site, Olpiro
	Game Drive	Through designated roads.
	Walking Safari	Through designated walking trails.
	Balloon	Allowed across the zone.
	Air strip	Endulen, Kakesio.
	Mobile Communicaton	Existng Towers: O and Endulen.
	Ranger Posts and Gates	Existng: Olkarien Gorge, Endulen and Kakesio and any other according to the need.

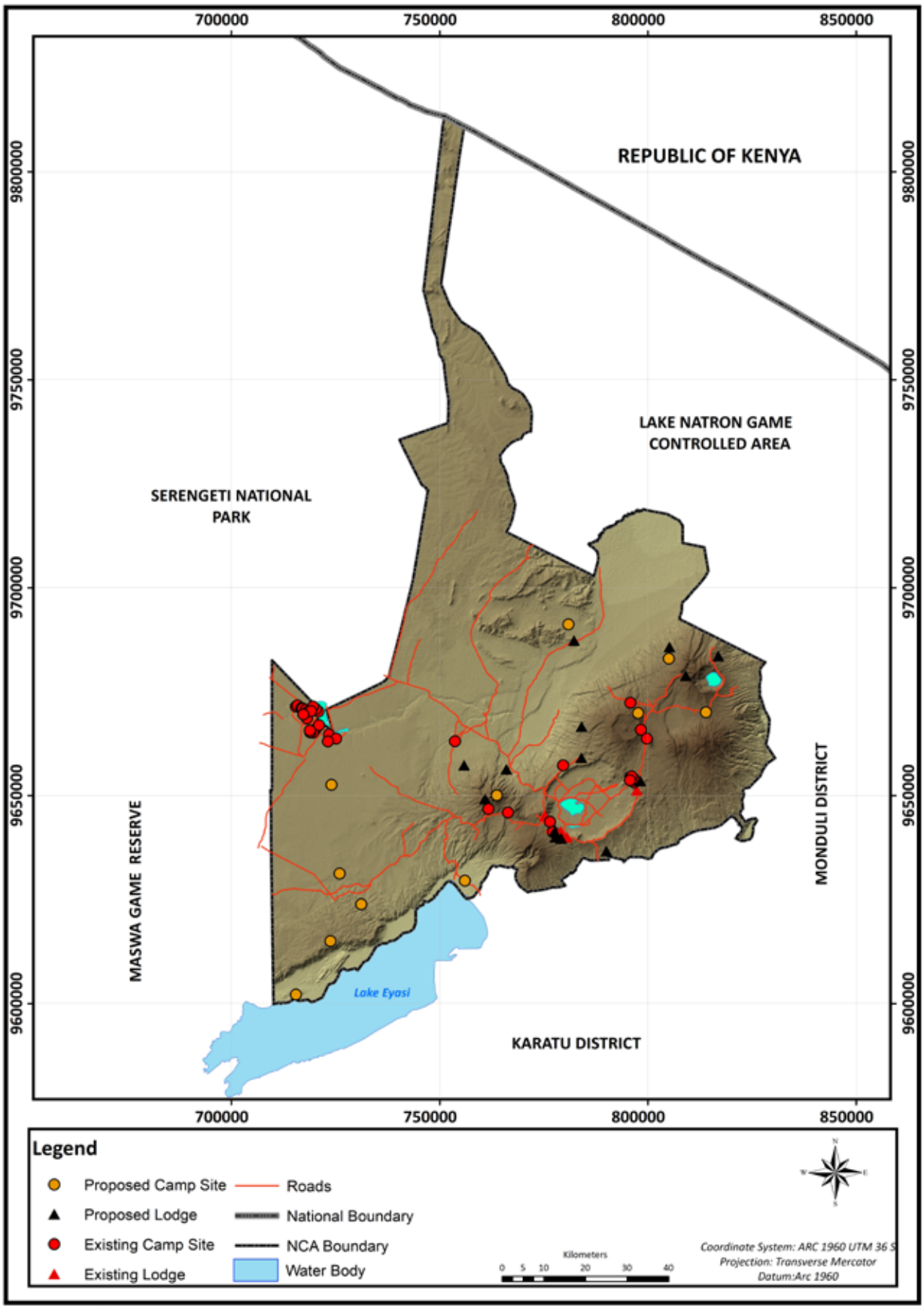
Aspect of the Zone		Detailed Descripton of the Z
		Stop Overs: designated stopovers lodges, picnic sites and ho
		Horse Riding: Designated areas.
		Hiking: Nasera rock and Gol Moun
	Commercial photography	Special permit required.
	Research	No Limits but undertaken wi TAWIRI and NCAA.
	Administration and facilities	Ranger Posts: New / new ranger po designated areas.
Specifcally uses	Off road driving prohibited.	
Other applicable conditons	Any investment or other actvites t permission.	

5.3.3 Loliondo Conservation Zone

This zone has an area of 1,069 square kilometres and covers the western part of the former Loliondo Game Controlled Area. It borders Serengeti National Park in the west, the Republic of Kenya to the north, and to the east, Piyaya and Arash villages in Ngorongoro district. Further description of the zone, its rationale and allowable uses and limits are shown in the following Table.

Aspect of the Zone	Detailed Descripton of the Z	
Ratonale zone	Habitat and dispersal area for wildl Masai Mara ecosystem, tourism atract	
Resource values	Flora and fauna species	
Management emphasis	• Maintain and protect wildlife breed • Control trophy hunting	
Uses	Types of Use	Limits of Acceptable Us
	Trophy hunting	Regulated as per hunting permi
	Tourism	Game drive, horse riding, safari walks, ballooning, walking trails and designated
	Commercial photography	Special permit required
	Research	Undertaken with permission of
	Administration and facilities	Allot necessary administratve leipteens ding on the need
Other applicaton conditon	Any other actvites to be undertaken All constructon/establishment of fac	

Map 29: Existng and proposed tourism ir



5.4 Environmental and Socio-Economic Appraisal of the Zoning Scheme

Environmental and Socio-Economic Appraisal refers to the assessment of potential impacts associated with any change in conditions of the resource, environment or socio-economic parameters. The purpose of the appraisal of the zoning scheme of the NCA is to ensure that adverse and positive effects of the scheme are outlined, and the former are mi purpose of the appraisal for the zoning scheme of NCA is as follows:

a) To ensure management actions have positive environmental effects and, where there are negative effects, they have the least possible negative impact;
b) To ensure that management actions to resolve existing problems do not create a series of other problems;
c) To identify mitigating actions to reduce, eliminate or offset adverse effects and incorporate those actions directly into the proposed option; and
d) To make informed decisions with a full understanding of the potential consequences.

5.4.1 Appraisal of the Zoning Scheme

Appraisal of the zoning scheme aims at assessing the impacts of key management actions on different environmental and socio-economic parameters. The key management actions of the zoning scheme are as follows:

a) Relocation of people and NCAA HQ offce o
b) Restoration of degraded areas.
c) Tourist hunting in the Loliondo conservation zone.
d) Fencing of the NCA southern border.
e) Hardening of the Lodoare to Golini road.

The criteria for appraising the above fve signifance of an impact, which ranges from to 2 (High signifcant positive impact). A parameter is signifcantly impacted (negat actions if it scores a total of 10 points. The management action with high signifcant impact (negative or positive) o parameters will score a total of 12 points.

Any score below 0 points will require mitigation measures to minimise adverse effects for sustainable conservation and development. Scores above 0 points

show positive environmental and socio-economic impacts and, therefore, should be enhanced to meet the desired future conditions of the NCA. In consideration of the latter (NCA resources and inhabitants), the selected environmental and socio-economic parameters include:

a) Biodiversity;
b) Rangelands conditions;
c) Tourists experience and satisfaction;
d) NCAA revenues;
e) Cultural heritage resources; and
f) Conflict between wildlife and people.

5.4.2 Environmental and Socio-Economic Impacts of Management Actions

5.4.2.1 Relocation of People, Livestock and NCAA HQ Offices Outside the NCA

Relocating people, livestock and NCAA HQ offices outside the NCA has the following impacts:

Positive Impacts

a) Elimination of human, livestock and wildlife conflicts;
b) Improved vegetation cover of the NCA.
c) Conservation of cultural heritage sites due to reduced pressure from anthropogenic activities.
d) Preservation of ecologically sensitive and fragile lands including wetlands/ swamps, springs, lakes and hills/mountains.
e) Enhanced protection of wildlife, craters, vegetation and water catchment areas.
f) Improved habitat for endangered and threatened wildlife species.
g) Preservation of archaelogical and cultural heritage sites and resources.
h) Improved aesthetic value of the environment.
i) Increased suitable areas for tourism investment.

Negative Impacts

a) Loss of traditional and cultural ties.
b) Social disturbances.
c) Loss of community social support network.
d) Relocation cost to the NCAA.

5.4.2.2 Restoration of degraded areas

Restoration of degraded areas involves initiatives for returning to a natural state or condition. This includes areas affected by soil erosion and invasive plant species, degraded forests and demolished human settlements, social facilities and infrastructres. The restoration of degraded areas will have the following impacts:

Positive Impacts

- a)Improved vegetaton cover of the NCA.
- b)Improved habitats for wildlife species.
- c)Improved and increased ecosystem servic
- d)Improved aesthetc value of the environm

Negative Impacts

a) Restoration costs to the NCAA.

5.4.2.3 Tourist Hunting in the Loliondo Conservation Zone (LCZ)

Hunting in Loliondo conservation zone will have the following impacts:

Positive Impacts

a) Generation of revenue to the NCAA.

b)Diversifed tourism products and hence im satisfaction.

Negative Impacts

a) Increased management cost to NCAA.

5.4.2.4 Fencing of the NCA Southern Border

Fencing of the NCA southern border will have the following impacts:

Positive Impacts

a)Elimination of conficts between wild anir of Karatu and Monduli districts.

b) Reduced management costs to the NCAA.

c) Reduced animal and human kills.

d) Reduced community encroachment to the NCA.

e) Controlled or reduced destruction of community properties by wild animals.

f) Reduction of zoonotic diseases.

Negative Impacts

a) Blockage of wildlife movements between the NCA and other protected areas.
b) Injuries and death to wild animals and people.
c) Cost of installation and management of the fence.
d) Theft of fencing materials.

5.4.2.5 Upgrading the Lodoare - Golin Road to Tarmac Level

Upgrading the Lodoare - Golini road to tarmac level will have the following impacts:

Positive Impacts

a) Reduced road maintenance costs to the NCAA.
b) Reduced traffc congestion.
c) Saving of time and energy due to improved accessibility.
d) Enhanced tourists' satisfaction and experience.
e) Increased number of vistors to the NCA.

Negative Impacts

a) Cost of construction of the road.
b) Injuries and death of human and wild animals due to accidents.
c) Loss of biodiversity in the construction area.
d) Possibility of environmental degradation in most visited sites due to increasing number of visitors to the NCA.

5.4.3 Environmental and Socio-Economic Impacts Evaluation

Environmental and Socio-Economic Impact Evaluation analyses the severity of impacts that management actions have on environmental and socio-economic parameters. This is done by rating the impact of a particular management action on a selected environmental and socio-economic parameter. The results of the evaluation help to identify and propose mitigation measures to minimise and/ or control negative impacts, and measures to enhance positive impacts. Impact rating for management actions on selected environmental and socio-economic parameters is presented in Table 37.

Table 37: Impact rating for management actions on environmental a

Environmental and Economic Parameters	Management Action					Total Scores
	Relocation of people and NCAA HQ outside NCA	Restoration of degraded areas	Tourist hunting	Fencing of the NCA southern border	Upgrading -Golin road to tarmac level	
1. Biodiversity	2	2	1	2	-1	**6**
2. NCAA revenues	2	1	2	1	2	**8**
3 Rangeland conditions	1	2	1	1	1	**6**
4 Tourists' experience and satisfaction	2	2	2	1	2	**9**
5. Cultural heritage resources	1	1	0	0	0	**2**
6 Conflict between wildlife and people	2	0	0	2	0	**4**
Total Scores	**10**	**8**	**6**	**7**	**4**	

KEY:

Score	Colour	Impact Level (Explanation)
-2		High significant negative impact
-1		Moderate negative significant impact
0		No impact
1		Moderate significant positive impact
2		High positive significant impact

5.4.4 Outcome of the Analysis

From the analysis it has been established positve impacts on all environmental and hardening of the Lodoare to Golini road NC biodiversity, it has an overall positve im and tourists' experience and satsfacton.

5.4.5 Impacts Mitigation Measures

In order to minimise or control the iden measures for each specifc management actio

a) Identify and allocate existing facilities suitable for tourism investment.
b) Develop and implement proper and cost-effective restoration plan.
c) Prepare Environmental Impact Assessment that will provide options for minimising adverse impacts to biodiversity during costruction of the road.
d) Install traffc signs and symbols in orde
e) Develop mechanism for controlling congestion of tourists and vehicles in most visited sites in the NCA.
f) Diversifcation of tourism products in th

5.5 Management Objectives, Strategies and Interventions for Achieving Desired Future Conditions

This secton presents the management acton objectves, strategies and interventons for 38). Interventons described in this sector a period of fve years. They are meant to m protect outstanding resource values and he of the NCA. The mitgaton measures identfe for addressing environmental and socio-ec management actons.

Table 38: Management Acton Plan (2021–2025)

Objective	Strategies	Targets	Activites	Time Frame (Years)				
				1	2	3	4	5
To ensure preservation of NCA's landscapes and its resources	Relocate people, livestock and NCAA headquarters outside the NCA	People, livestock and NCAA headquarters relocated outside the NCA by 2023	Delisiv gensattec ka areas for relocatng people					
			Relocate people and livestock out of the NCA					
			Relocatng NCAA HQ ofce outside the NCAA					
	Develop and implement mechanisms for controlling land degradaton	Water quantity and quality in the ecosystem improved by 2031	Dtetvye lop and implement intergrated water resources					
			Construct and manage drainage systems along roads					
			Construct infrastructures for managing storm water to control ersosion					
			Develop and implement waste management plan of the					
			Establish and operatonalise waste collecton points					
			Establish waste disposal sites outside the NCA					
			Install signboards prohibitng litering					
			Conduct periodic inspecton for waste management co					
			Identfy and establish permanent toilets to shorte facilites					
		Indigenous vegetaton cover of the NCA improved by 2031	Identfy and restore degraded areas in the NCA					
			Review and implement the Invasive Alien Plants Str					
			Develop and implement wildfre control strategy for					
	To control encroachment on NCA resources	Land use districts and villages bordering the NCA prepared by 2022	Plaacnisliftoarte preparaton of district land use framew the NCA					
			Facilitate preparaton and implementaton of land us the NCA					

Objective	Strategies	Targets	Activites	Time Frame (Years)				
				1	2	3	4	5
	Protect wildlife in the NCA	Wildlife diseases in the NCA controlled and reduced by 2031	Prepare and implement wildlife diseases control p					
			Establish and operatonalise wildlife treatment cen					
		Wildlife the NCA monitored and documented by 2031	sDpeevœileosp iannd implement Threatened and Endangered Strategy for the NCA					
			Undertake periodic monitoring of wildlife species					
			Conduct regular patrols to prevent illegal actvit					
			Undertake wildlife census for diferent wildlife sp					
			Establish and operatonalise database for wildlife					
To improve el mtporuorvies trso ’ aduri sm sitest work and experience and access to biodiversity and cultural heritage resources in the NCA		Tourism sites within the NCA easily accessible throughout the year by 2031	Assess the status of all roads in the NCA					
			Map road network in the NCA					
			Construct new roads linking tourism sites in the NCA					
			Undertake periodic maintenance of all roads in th					
			Hardening of the descending road to Ngorongoro Crater					
			Upgrade Lodoare-Golin road to tarmac level					
	Improve ai services in the NCA	Air transport services within the NCA improved by 2031	Pterriodic maintenance of existng airstrips in the N					

Objective	Strategies	Targets	Activites	Time Frame (Years)				
				1	2	3	4	5
	Improve tourism services in the NCA	Quality standards for NCA tourism services and facilites developed and implemented by 2031	Develop quality standards for NCA tourism service with relevant stakeholders					
			Convene periodic meetngs with stakeholders (hotel safari guides) to deliberate and ensure compliance services and facilites in the NCA					
		Tour guiding services in the NCA improved by 2031	Prepare and disseminate visitors educaton material tourist routes and specifc points of interests)					
			Develop, create awareness, distribute and enforce the NCA's resources and atractons					
			Prepare and install relevant exhibits along the ma					
			Periodically provide informaton to make tour guide conditons, animal locaton or road status					
			Recruit and assign mult-lingual personnel at all e					
			Construct a modern visitor centre					
			Develop and disseminate interpretaton materials					
		Code of conducts by tour guides and interpreters improved by 2031	Employ and assign qualifed tour guides and interpr					
			Develop standards for tour guides and interpreters					
			Build awareness amongst tour operators of the use interpreters					
			Introduce and enforce dress code for tour guides a					
			Undertake periodic inspecton and monitoring to ens					

Objective	Strategies	Targets	Activites	Time Frame (Years)				
				1	2	3	4	5
	Increase tourists accommodation in the NCA	Adequate accommodation facilites for tourists in the NCA by 2031	Establish new lodges and ecampsites in designated					
			Establish picnic sites in designated areas					
			Establish hot meals centres in designated areas					
	Diversify NCA tourism products	NCA tourism promotion and products increased by 2031	Introduce ballooning and horse-riding actvites in					
			Establish cable transport facility at Empakai Crat					
			Prepare and disseminate NCA tourism marketng strat					
To ensure preservation of cultural heritage resources of the NCA	Improve management of cultural heritage resources in and outside the NCA	Cultural heritage resources in and outside the NCA preserved by 2031	Conduct routne maintenance of cultural heritage r NCA					
			Build walls to protect discoveries from wind/soil					
			Periodically monitor land use change and impacts i					

CHAPTER SIX: IMPLEMENTATION, MONITORING AND EVALUATION FRAMEWORK

6.1 Introduction

Implementation is the most important, but stage of the management plan in the majority of protected area authorities and systems. Clear strategies and defned proce and effcient implementation of the manager values, signifcance statements, vision and why it is needed. Objectives, strategies, targets and activities highlight what the NCA must do to achieve its desired future.

In order to implement the activities detai human resources will be required. It is expected that these resources will be outlined in the Annual Operation Plans and Budgets (AOPB). The AOPBs will require the NCAA management to determine adequate resources for achieving intended outputs, which will be periodical for implementing NCAA Annual Plans and Budgets. By annotating the MZP in the form of the Logical Framework approach, the NCAA management will be required to assign discrete tasks to speci to develop a good rationale for each initiative, to set deadlines and to determine types and amounts of resources required. In addition, based on NCA management programmes, NCAA managers will be required to form ad hoc working groups, task forces, or special committees in order to accomplish a particular initiative. Apart from developing the AOPBs, other strategies that will ensure success in implementing the MZP include purchase of e and flling of staff workloads gaps through

6.2 Development of Annual Operation Plans and Budgets

The Annual Operation Plan and Budget (AOPB) is a yearly administrative plan prepared by NCAA departments detailing sp during the fscal year. The department resp matters will coordinate and lead other departments (Annual Operation Plan and Budget Committee) in the preparation of AOPBs for the NCAA. NCAA management will appoint members of the AOPBs committee from all NCAA departments. The AOPB should delineate s resources and amount of funds to be disbursed each year to implement the MZP. Therefore, each year, and based on the GMP, the AOPBs will identify annual activities and prepare annual budgets. The AOPB needs to prioritise

targets and subsequent activities and set a realistic timetable. This MZP is a multi-year plan, and everything cannot be be developed each year in order to avoid being overloaded or overwhelmed.

6.3 Staffing Requirements for Implementing the MZP

Determination of number, type and competences of required staff for effective and effcient implementation of the MZP wil of Human Resources and Administration. Nec undertake different departmental tasks will be stipulated in the NCAA Scheme of Services, which will be developed in collaboration with all NCAA departments. In each year, the Department of Human Resources and Administration will prepare budgets (staff remuneration), coordinate recruitment and assign staff to undertake different tasks for each department.

6.4 Fixed and Movable Capital Requirements for Implementing the MZP

Determination of fxed (buildings, roads, e road maintenance equipment, radios, offce capital required for implementing the MZP will be undertaken by relevant departments of the NCAA considering their functions.

6.5 Monitoring and Evaluation Framework

Monitoring progress and setting up milestones is key in ensuring effective implementation of plans. A monitoring plan establishes a system of accountability or a mechanism to measure progress. On the other hand, evaluation and acknowledging results is also essential. After 5 or 10 years of implementation, if all has gone well, the results will match or come close to the original expectations expressed in targets and strategic objectives. In certain instances, a strategic objective that has not been accomplished quite as intended may still bring some unexpected benefts. In any case, the task are very enjoyable; recognising and celebrating completed tasks, encouraging efforts that are ongoing, and showcasing the vision realised by putting the MZP into action. Thus, a monitoring and evaluation plan supports efforts by the NCAA to implement the MZP effectively and effci

Monitoring and evaluation are essential management functions that are interactive and mutually supportive. Monitoring is an ongoing process of collection, storage and analysis of data for improved MZP implementation. The following are the objectives of monitoring the MZP:

a) Compliance with NCAA policies, procedures and legislation;
b) Provide early indicators of progress, or lack thereof, in the implementation of the MZP;
c) Identify risks and adverse environmental impacts of implementing the MZP;
d) Control and improve the MZP on the basis of practical information; and
e) Assess whether the MZP continues to be relevant as implementation unfolds.

Monitoring and evaluation of the MZP will be undertaken at the end of every financial year, guided by the Monitoring to be prepared based on the management objectives, targets and related interventions. The Monitoring and Evaluation Matrix will contain the following information:

a) Strategic objectives, as envisaged by the Corporate Plan;
b) Targets;
c) Verifable indicators
d) Monitoring frequency
e) Means and sources of verifcation; and
f) Roles and responsibilities for collection and management of collected data.

On the other hand, evaluation is a time-bound exercise that attempts to assess, systematically and objectively, the impa relevance of an ongoing or completed MZP. Evaluation can take place:

a) When the MZP is underway (mid-term);
b) On completion of the MZP (end-of-the plan); and
c) A number of years after completion of the MZP (ex-post evaluation).

Once the MZP is partially or completely implemented, it would be useful to look back over what took place, to compare actual progress with the plans, and judge whether the decisions and actions taken were reasonable and useful. This kind of analysis would help not only in the management of the MZP during and after the initial implementation phase, but also in preparation of a future MZP, and in the review of current conservation planning and management policies, practices and legislations. Therefore, it would be important for the NCAA to draw Terms of Reference and contract an independent consultant to carry out mid-term, end-of-the plan and ex-post evaluation exercises. The Monitoring and Evaluation Framework will help the consultant in the assessment of impacts, relevance, effciency and effectiveness of the MZP.

6.5.1 Progress Reporting

The AOPBs committee in coordination with the Department of Planning and Investment will prepare progress reports for implementation of the MZP. Quarterly, midyear and annual reports will be prepared and submitted to NCAA management, which will submit them to the Board of Directors. These reports will detail the level of achievement of objectives, targets and activities as detailed in this MZP and based on the M&E Matrix for AOPBs.

6.5.2 ZMP Review Principles, Conditions and Procedures

6.5.2.1 Review Principles

In principle, the MZP must be adapted to changes in policy and legislative environments, as well as fnance, socio-ec tourism trends. Technological advancements NCA scenarios. All principles of the MZP design must be adhered to during its review, including involvement of key stakeholders, interaction of stakeholders during the review and regional context in MZP coverage.

6.6.2.2 Review Conditions and Procedures

There shall be two types of MZP reviews, namely, Compulsory Review and Incidental Review. Compulsory Review is mid-term (after three years of implementation) and end-of-MZP (after fve Review occurs when circumstances dictate change of the MZP or certain incidences occur to justify the change or review. These incidences shall be submitted to and defned by the NCAA manag Board of Directors or, in their absence, the Permanent Secretary of the Ministry responsible for natural resources and tourism. Compulsory Review shall be mandatory and no approval shall be requested from the Board of Directors or the Permanent Secretary of the Ministry responsible for natural resources and tourism. If an Incidental Review takes pla the mid-term review is not required.

Therefore, the MZP shall be reviewed only if:

a) Mid-term review and end-of-MZP term conditions are met (third year and ffth year of MZP implementation respecti
b) NCAA management provide evidence of substantial change of circumnstances that infuence the NCA and of Directors – Incidental Review can tak

c) Authority or authorities that appoint Board of Directors give directives and rationale for the review of the MZP to the Chairperson of the Board of Directors. Incidental Review can take place in this respect.

6.6 Validity of the MZP

If the timing of Compulsory Reviews (mid-term review and end-of-MZP term review) is delayed for any reason, it will not affect the validity of this MZP. Moreover, this MZP becomes valid after gazzettment by the Minister responsible for natural resources and tourism.

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Ngorongoro Conservation Area Authority
P. O. Box 1
Ngorongoro Crater
Arusha, Tanzania