Wildlife, Livestock and Human interface in the Ngorongoro Conservation Area: A review

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Abstract
Competition for land in rangeland areas which in most cases have limited livelihood options is a major obstacle to socio-economic development of the pastoralists and agro-pastoralists. Unfortunately, at the time that there are increasing calls for agriculture-led growth in Africa, there is also increased international awareness of the importance of biodiversity conservation, both of which are land-based. The link between rural development goals, especially poverty alleviation and biodiversity conservation, has for a long time been debated in the scientific literature with opposing views on whether or not the two can simultaneously be achieved. This situation is evident in the Ngorongoro Conservation Area (NCA) in north east Tanzania where people co-exist with wildlife and livestock and where other livelihood options such as cultivation is not allowed and grazing is restricted in some areas (within the crater and in the Northern Highland Forest Reserve). This paper reviews the human-wildlife-livestock interface in this unique protected area with international biodiversity conservation importance which thrives to achieve three goals of conservation of biodiversity, tourism, and community development of the Maasai, Datoga and Hadzabe; the three main ethnic groups within the NCA. The findings indicate that for the past six decades since her establishment, the

Ngorongoro Conservation Area Authority (NCAA) has been experiencing a number of challenges and success stories. The major challenges among others have been increased human-conservation conflicts, disease outbreaks, climate change, increased alien invasive species, and increased human-wildlife-livestock population. On the other hand, the NCAA has been successful in achieving her goals of increased revenues through tourism, conservation of biodiversity and cultural heritage, continued co-existence of humans and animals, support of socio-economic development programmes, and improving the community livelihood. For NCAA to continue surviving for many years to come requires innovative ideas and strategies. Among others should include integrating ethno-modern science range management, increased involvement of community in major issues affecting their livelihoods, strengthening research, destocking, and use of participatory general management plans.

Keywords: *Rangeland, Ngorongoro Conservation Area, protected area, geo-park, land use conflicts, livelihoods*

Introduction

Competition for land in rangeland areas and other natural resources in the developing world is a major obstacle to socio-economic development of the pastoralists and agro-pastoralists with very limited livelihood options. Unfortunately, at the time that there are increasing calls for agriculture-led growth in Africa, there is also increased international awareness of the importance of biodiversity conservation, both of which are land-based. The link between rural development goals, especially poverty alleviation and biodiversity conservation, has for a long time been debated in the scientific literature with opposing views on whether or not the two can simultaneously be achieved. This scenario calls for innovative ideas to achieve a win-win situation.

Although wildlife conservation approaches have shifted over the years from largely exclusionary policies of using fines and fences to keep out rural communities in particular pastoralists and agro-pastoralists to approaches that recognize the role that rural communities can play in wildlife conservation and rangeland management, controversy still surrounds the human/wildlife/livestock interface and its socio-economic impact on rural communities (Kaswamila, 2012). The interface is multi-faceted and has both positive and negative implications for health, environment and economics. On the other hand, however, it is argued that increased wildlife/livestock/human interaction could lead to local conflict, competition for land, and transfer of animal diseases (Chubwa et al., 2019). In other words, key issues in the interface include not only human and animal health, but also environmental and ecosystem conservation and economics.

Reconciling wildlife/livestock/humans interface and rural development goals is a challenge that most African countries

endowed with rich natural resources, particularly wildlife, have to contend with. The challenge is further exacerbated by the fact that high values placed on wildlife conservation internationally do not usually translate with local level benefits for communities - the unpaid conservationists that bear the day-to-day costs of living with wildlife.

In many areas of Africa the traditional rangeland management system is argued to be no longer able to cope with the shortage of pasture and instead is adding to the problem of land degradation (Bhattaral, & Upadhyay, 2012). The Ngorongoro Conservation Area (NCA) which is a multiple-land use protected area category (humans co-exist with wildlife and livestock) can probably be a success story despite increased populations of wildlife, human and livestock. The integration of modern science and ethno-ecology has to a certain extent worked well. The objective of this paper is illuminate the NCAA strategies in managing human, wildlife and livestock interface challenges for the past six decades dramatic increase of humans, wildlife and livestock.

The study area

Ngorongoro Conservation Area (NCA) (8,292 km^2) established in 1959 is a worldwide unique protected area category where people co-exist with wildlife and livestock and within it there is the famous Ngorongoro Crater (250 km^2). It is located at Latitude 03°14'.715 S and Longitude 35°29'.275 E and is bordered by several protected areas that form the Serengeti-Mara Ecosystem (SME) (Fig. 1). The multiple land use protected area category has three major ethnic groups, the Maasai who are the majority, the Datoga and the Hadzabe. The latter are hunter-gatherers and the remaining are pastoralists. Cultivation, grazing within the

Northern Highland Forest Reserve (NHFR) and within the Crater is prohibited.

The major functions of the NCAA are threefold: conservation of natural resources, tourism, and community development. The protected area has several international recognition statuses. In 1979 it was inscribed by UNESCO as a World Heritage Site based on its outstanding universal values; in 1981 as part of Serengeti-Ngorongoro Man and Biosphere Reserve (MAB); in 2010 as mixed natural and cultural property; and in 2018 as Ngorongoro-Lengai Geo-park.

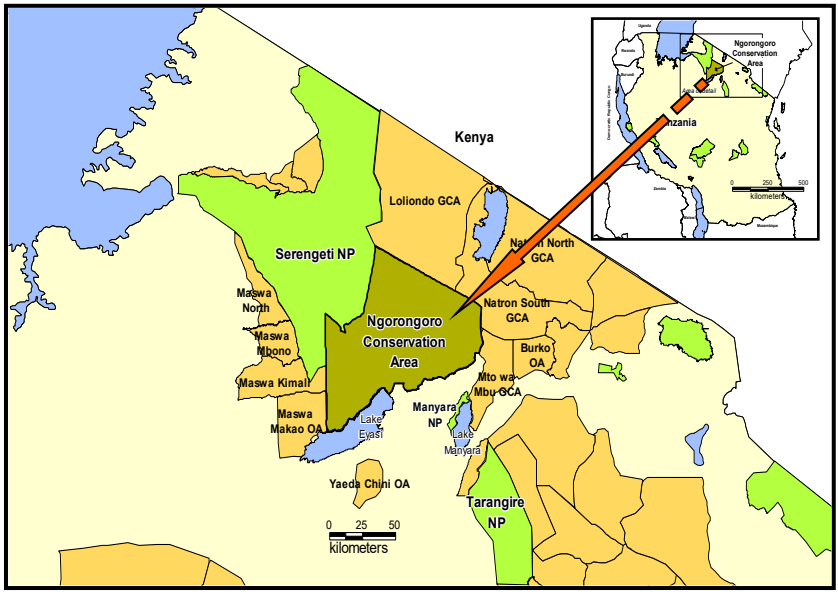

Figure 1: Location of the Ngorongoro Conservation (NCAA, 2018)
Trend of human/livestock/wildlife within NCA

Between 1960 and 2017 human, wildlife and livestock populations within the NCA has been increasing (Table 1) while the area for grazing has been decreasing as result of anthropogenic activities and alien invasive grass species.

Table 1: Trends in human, livestock populations between 1960 and to 2017

Year	People	Cattle	Small stock
1960	++++10,636	++++161,034	++++100,689
1966	++++7,387	++++94,580	++++68,590
1970	++++5,435	++++64,766	++++41,866
1974	*12,665	+123,609	+157,568
1977	++++16,705	++++110,584	++++244,831
1978	++++17,982	++++107,838	++++186,985
1980	*14,645	+118,358	+114,675
1987	*22,637	++137,389	++137,393
1988	++++26,743	++++122,513	++++152,240
1993	++++37,352	++++77,243	++++148,288
1994	*42,508	*115,468	*193,294
1998	++++52,000	++++120,000	++++195,000
1999	*51,621	*117,300	*164,049
2002	**57,000	+117,984	+179,053
2007	***64,842	***136,550	***193,056
2013	+++87,851	+++131,509	+++330,079
2017	****93,136	****238,826	****570,633

Source: *Kijazi et. al. (1997; ++++ NCAA (1999); **URT, (2003), ***NCAA (2007), +NCAA Community Development Department records (2010), ++ Perkin (1997), **** NBS (2017), +++ URT (2013)

On the other hand, the number of large wildlife herbivores has also been on the rise. According to Boone et al. (2002) and NCAA (2017) the rise (numbers in brackets) is as follows:; migratory wildebeest (625,000), migratory zebra (62, 959), migratory grazing antelopes (150,000), resident wildebeest (9,000), resident zebra (7,087), resident grazing antelopes

(13,600), buffalo (2,836), browsing antelope (2654), elephant (300), rhinoceros (59), giraffe (1666) and warthog (45).

The increase in rangeland degradation due to human and livestock has led to human-conservation conflicts, low livestock productivity, diseases outbreaks, and increased poverty among local communities whose livelihood entirely depends on livestock keeping. According to Chubwa et al. (2019), the Ngorongoro district (NCA part of) acts as a hyper-endemic area for anthrax, which is a cause of major concerns to both the local population and conservation. For the latter, if not well addressed may affect tourism, which is important source of revenue in the area and the country at large. They further argue that, practices of processing and consumption of infected carcasses cause high disease risks to humans, while movements of livestock to contaminated areas in search of pasture, water and minerals are the main drivers for livestock diseases.

Land use-Land cover of the NCA

The NCA vegetation, which is spatially variable, is influenced by rainfall and topography. Herlocker and Dirschl (1972) delineated NCA vegetation cover into eight categories namely mountain heath, bamboo forest, evergreen forest, high woodlands, low woodlands, medium grasslands, short grasslands and sand dunes grasslands. Homewood and Rodgers (1991) condensed this classification into four broad types, which are, the mountain forest, highland shrub and grassland, open woodlands and bush land as well as the plain grasslands, which are found in the drier lower ground to the west and south of the NCA. The Northern Highland Forest (NHFR), which also contains a bamboo forest, is a vital water catchment area for the larger part of NCA and

neighboring agricultural communities. The forest covered slightly above 930,000 km^2 in 1975 but with time due to encroachment, it shrunk to about 140,000 in 2000 (Table 2).

Table 2: Land Cover Types in NCA for 1975, 1991 and 2000

Land Cover Type	**Hectares and percentage of total cover area**					
	1975		1991		2000	
	Hectares	%	Hectares	%	Hectares	%
Forest	93,128.6	11.6	141.940.6	17.7	138,437.0	17.2
Mountain heath	24,235.4	3.0	24,235.4	3.0	24,235.5	3.0
Woodland	11,066.2	1.4	143,417.5	17.9	142,735.7	17.8
Scrubland	165,290.2	20.6	117,737.2	14.7	118.971.6	14.8
Bushland	28,048.5	3.5	40,012.2	5.0	40,012.0	5.0
Lowland/ midland grassland	449,875.1	56.0	282.977.0	35.2	283.307.1	35.3
Highland grassland	25,438.8	3.2	32,453.2	4.4	34,187.1	4.3
Cultivated area	108.9	0.01	16,909.1	2.1	17,695.9	2.2
Bare ground	31.2	0.004	807.7	0.1	1,021.7	0.13
Wetlands	2,863.0	0.5	--	--	44.0	0.01
Water bodies	3,000.0	0.4	3,001.0	0.4	2,408.5	17.8
Total	802,898.6	100.0	802,898.4	100.0	803,056.5	100.0

Source: Niboye, 2010

Analysis of 2008 and 2018 Landsat images (Landsat MSS 2008 and Landsat MSS 2018 respectively) revealed remarkable decrease in NHFR cover from 376 km^2 to 131.2 km^2 over a period of 10 years. Outside NHFR are found other remarkable forests including Layanai, which is composed mainly of *Acacia lahai, A. xanthophlea* and *A. Tortilis*, the Misigiyo that is located at higher

altitudes of more than 2,500 metres above sea level on the slopes of Satiman and Makarot, which is dominated by *A. lahai* and *Juniperus procera*, and similar vegetation type on the slopes of Loolmalasin Mountain. The Ngorongoro Crater, which is dominated by grassland, contains the groundwater. *A. xanthophlea* at the Elerai forest covering approximately 5 km^2 and a small patch of the same species at Ngoitoktok springs (NCAA, 2006).

The highland grasslands consist of the Melenda Plateau and the Embulbul Depression. The Embulbul is a low-lying grassland plain, which is densely settled supporting a larger proportion of human and livestock populations than any other part in the NCA (NBS, 2017) but accommodating sparsely scattered wildlife. These grasslands are heavily grazed by livestock, and due to over-use of these ranges many parts of the Ngorongoro Highlands have been invaded by unpalatable tussock grasses.

The spread of indigenous invasive plant species including the buffalo grass (*Eleusine jaegeri)* and *Pennisetum schimperi* have been associated with overgrazing, lack of burning and climate change. The buffalo grass often grows on disturbed ground. This plant appears to increase at the expense of more palatable grasses. Cattle that feed on this type of grass, which has a hard-calcareous outer casing, display faster tooth wear than others (NCAA, 2006). Some parts of the highland grasslands have adequate water throughout the year, and this has contributed somehow to the relatively poor range conditions. In spite of water availability, range conditions become even poorer during the dry season, which obliges pastoralists to move and graze their cattle in NHFR and the craters of Olmoti and Empakaai. The wooded grasslands

both located in the midland and highlands are densely settled by pastoralists thus support sparse populations of wildlife.

Comparison of vegetation change over a period of 10 years showed that overall the woodland and highland grassland types of vegetation increased between 2008 and 2018 while shrubland and riverine vegetation decreased over the same period of time (Bukombe et. al. 2018). However, Bukombe et. al. (2018) noted that lowland and midland grassland vegetation type may have decreased over the period of assessment because the newly established agricultural land could have appeared as grassland areas. A combination of two different analyses (1975-2000) and (2008-2018) confirmed that there was progressive vegetation change from grasslands towards woodland and a remarkable increase of shrubland and highland grassland (MNRT, 2019).

The analysis revealed further that there was an increase in bare soil mostly in areas which were previously covered by grassland vegetation especially in Embulbul depression, Olbalbal and Ndutu plains. The most probable factor for the change being overgrazing by small stocks especially sheep, which are increasingly kept due to the fact that they are relatively resistant to harsh environment particularly drought and diseases than cattle. According to NBS (2017) number of cattle and small stocks (sheep and goat) in 1994 was 115,468 and 193,000 respectively and by 2017 the number of cattle rose to 238,268 and 570,633 for small stocks. This implies that for two decades the number of of cattle doubled and that of small stocks tripled.

Most vegetation changes in NCA particularly those, which favour dominance of woody species with decreasing trend in forests and

grassland vegetation, are associated with anthropogenic activities such as overgrazing by livestock, land clearance for cultivation and harvesting of forest products (Herlocker, 1999; Niboye, 2010; Bukombe et. al., 2018).

Indigenous methods of managing rangelands in the NCA

Indigenous methods of managing rangelands within NCA have also been instrumental in reducing rangeland degradation and intra-community conflicts. The different methods in use include seasonality management, dividing areas in portions (*Alalili*), rangeland zonation, custodians of common in pastures, use of cosmologies of Maasai and rituals, mobility, reciprocity management, sharing of wildlife habitats and burning habitats (Mafula, 2015). The details are provided hereunder.

Seasonality management

During the rainy season, the low lands (*Orpukel* area) are having quick growing, palatable and nutritive grasses and short time water availability in natural ponds, this time pastoralists, leave the highlands and moves to these low land areas, these areas are close to open plains near Ndutu scattering near Mosonic/Oloinyolengai and Lake Natron area, and near Irkarian gorge. Normally livestock stays here between December to February, when they leave to give room to wildebeest calving time and avoiding malignant catarrhal fever (MCF) disease; livestock again go back to these areas between March and May depending on the situation of rainfall each year. The whole of this time the highland areas will regenerate enough pastures that will be used by pastoralists during dry season (between June and November).

Dividing area in partitions (Alalili)

Alalili is portion of land for cattle, small calves, goats/sheep, with specific cultural values and significance that is reserved for over a period of time so as to be utilized during acute climatic conditions common in highland areas. Designation of land as *Alalili* is relative to the importance attached to a particular foraging zone. The existence of good quality grasses, the presence of rangeland ritual sites, and the historical attachment of the area qualify a rangeland to be canonized as *Alalili*. They also have areas that are not used during a certain period of time and will be later used by calves, bulls or old cows. These areas have also been quite important for wildlife especially those that run away from carnivores and or those that run out of the forest when there is heavy rain. This diving of land into portions can operate within villages.

Rangeland zonation

This is common as a way of traditional methods in land management. It is a way of managing land but also to maintain pastures and sustainability. The way this is operationalized is that, a place that you don't use for some period of time, must be used later to maintain rotational grazing pastures. This system has been useful for livestock living in harsh environments and/or conditions, including responses to climate changes. Zonation of rangelands behaves the way *Alalili* management does but mainly for larger areas beyond villages and wards depending on the natural ecological set-up of highlands and lowlands.

Custodians of common in pastures

The traditional Maasai system is hinged on the fact that land is for commons and not for individuals. The custodian ownership of

natural resources had for long, secured resources from being mismanaged by individuals. Traditional institutions especially *Laigwanan* (respected traditional elders - leaders) have very power influence on this.

Cosmologies of the Maasai and Rituals in Managing Rangelands

The rangeland in the NCA is much connected with some ritual activities of the community which has led to some areas to be respected. There are areas which have some rituals significant/cultural values and these areas are connected to intellect of people to use spiritual values aiming at maintain the area. Examples include): the Ngorongoro crater plains, which are said to be a vital hub for rangeland rituals, especially rain-making rituals and animal-health rituals. Other respected areas attached to rituals include the Olmoti and Empakaai Craters, Oldoinyo Lengai and Kirim; the Emunge River, Lolmalasin Mountain; the Ngorongoro Crater rim; Oloirobi highlands; and the Gol Mountain and Irkarian gorge.

Livestock Taxonomy

In NCA pastoralists divide livestock into various groups like bulls, milk cows, old cows, pregnant cows and the younger calves, weak, sick etc. This has been helpful in giving opportunities for healthy cows to walk away for pastures and the calves and weak cows/bulls to remain closer to Bomas. This has been very instrumental in land management and making efficient use of pastures.

Reciprocity Management

This is based on the hypothesis that nature takes its own cause. For example, some places getting rains before the others thus

providing mutual benefits through reciprocity. If it rains at side A and not side B, then all pastoralists might use under special management side A, and the inverse is done when it rains at side B.

Sharing wildlife habitats and avoiding wildebeest calving time
Technique of sharing with wild animals the habitats has two important elements, one, when wildebeest give birth, livestock move and leave the area to wildebeest, and later wildebeest move and livestock will go back, because of food facilitations, there is always a means that, this reciprocity has significant important in land management, likewise, some areas at a certain time of the year can be left by pastoralists because there will be a lot of carnivores and during that time, habitats regenerates.

Other indigenous methods in use have been burning of habitats (they know when to burn) and mobility of livestock. For the latter, during time of stress (drought), livestock moves to highlands, and during time of rains livestock move from highlands areas (e.g. forests) to lowlands.

Challenges associated with the co-existence of different production systems within NCA
The co-existence of different production systems (pastoralism, conservation and settlements) in the NCA has been possible through NCA Act, Cap 284 R.E. 2002. The Act allows the three production systems to co-exist. The co-existence can be argued to have recorded positive developments as well as challenges. The positive developments have been increased revenues through tourism amounting to about TZS 120 billion/annum, provision of socio-economic facilities (schools, health centres, water,

improved road infrastructure, dams, pupils/students scholarships, veterinary services etc.), conservation of biodiversity (NCAA, 2019).

On the other hand, the co-existence has led to a number of challenges. These include human-conservation conflicts such as livestock and human predation, insufficient grazing areas, diseases transmission from wildlife to livestock and vice versa, limited availability of salt licking areas, and inadequate supply of water (dams) for livestock and human use (NBS, 2017). Other challenges include lack of employment opportunities for local communities, increased livestock and human population, inadequate food, high illiteracy level, crop production restrictions, and increased poverty among the local communities (NBS, 2017). The driving force to most of these challenges can be argued to be and/or conflicts emanating from land availability pressure, pasture stress, restrictions to undertake economic development activities and non-involvement of communities in major decisions affecting their day-to-day life (Kaswamila, Pers. Obs).

To reconcile human-conservation conflicts and other challenges the NCAA in collaboration with the Ngorongoro Pastoral Council (NPC) (community representation body) has been using different mechanisms to mitigate some of the challenges. The mechanisms include provision of destocking education, paying of consolation for affected communities, manual elimination of invasive grass species, construction of schools within and outside NCA, strengthening of veterinary services, initiation of income generating projects (honey projects, campsites, establishment of souvenirs shops etc.) and construction of more water points for livestock and human use.

As stated earlier, the co-existence has been cemented by law. However, there are other mechanisms which have also been instrumental in enhancing co-existence. Among others include the presence of the Ngorongoro Pastoral Council (NPC) as a community link between communities and NCAA in addressing issues and problems of the communities living in the NCA, available policies and/or strategies (national and organisational), use of General Management Plans (GMPs), and the presence of Board of Directors which is the overall overseer of management and functions of the NCAA. The local communities' perception with regard to the NCA multiple land use system can be described as of mixed views, the majority being dissatisfied (Kaswamila, Pers. Obs.). The increased human and livestock over a fixed land area and associated challenges demand a review of the current conservation model. In the review, issues which need to be re-looked at include limits acceptable use for both livestock and humans, infrastructure developments within the NCA, food security enhancement (farming outside NCA), voluntary relocation with compensation, enhancement of livestock improvement programs, and destocking. The latter can be achieved through initiating awareness education on the pros and cons of having large number of livestock in a limited land area.

NCAA strategies in managing human, livestock and wildlife interface

NCAA has been using several strategies and/or approaches in managing human, livestock and wildlife interface namely the use national natural resources related policies, implementation of International conventions/Treaties/Agreements, use of participatory General Management Plans (GMPs), use of

prescribed fires and integration of modern rangeland management and traditional rangeland management techniques as detailed hereunder.

Land based Policies and natural resources conservation

Different natural resource management related policies mainly the national livestock, environment, land, and water policies have to a larger extent helped NCAA to achieve sustainable management of natural resources within the NCA. For example, the National Livestock Policy of 2006 takes cognisance of the importance of conservation of natural resources and environment. This is clearly indicated in one of its objectives, which states that, "*to balance the optimal use and conservation of natural resources i.e. land, soils, water and vegetation so as to conserve the environment'* (URT, 2010). This policy statement has great implications to NCA where livestock production and natural resources are the major land uses, which need to be harmonized. In order to achieve that balance any approach to ensuring that the multiple land use model remains sustainable, in terms of quality rather than quantity livestock production through cross-breeding the traditional zebu breed with improved races and ultimately have few cattle numbers of high productivity and profitability should be a prerequisite.

On the other hand the National Environmental Policy of 1997 emphasizes that environmental considerations should not become an afterthought in planning and decision making; rather it should be part of a conscious awareness of Tanzania's development realities. The policy puts more emphasis on public consultations as the most effective way during the process of initiating development projects (URT, 1997). Environmental Policy states that wildlife resources shall be protected and utilised in a sustainable manner on the basis of careful assessment of natural heritage in flora and fauna, fragile ecosystems, sites under pressure and endangered species, with participation of, and benefit to,

the local communities. The Policy advocates further that tourism development will be promoted based on careful assessment of the carrying capacity and prior EIA application. Environmentally friendly tourism including eco-tourism and diversification of tourism activities will be promoted, e.g. conservation and promotion of cultural heritage sites, in order to decrease pressures on heavily impacted areas. Financial benefits from tourism activities shall accrue in part to the local community to motivate them in conservation of tourism resources. This policy underscores the importance of NCA to develop projects as per General Management Plan (GMP) provisions.

Further, the National Land Policy of 1995 aims *"to promote and ensure a secure land tenure system that will encourage the optimal use of land resources, and to facilitate broad-based social and economic development without upsetting or endangering the ecological balance of the environment"* (URT, 1995). In order to ensure that NCA land is utilized optimally and facilitate a broad-based socio-economic development, any land use including the establishment of tourist, community and natural resources conservation facilities as well as grazing and game viewing patterns should be designed in an environmentally and sustainable manner in order to preserve the inherent natural, cultural-historical and wilderness characteristics and engendering regional self-sufficiency for the purpose of benefiting NCA local community and Tanzanians without compromising international interests.

The National Water Policy of 2002 on its part recognizes the intricate linkages between water and socio-economic development including environmental requirements; and because NCA faces acute scarcity of water both in quantity and quality, if a multiple land use model is to be sustained, intensive survey of water availability in NCA to uphold the growing resident human population, which now approaches 100,000 people and their livestock, service provider's staff and their families as well tourists so as their facilities should be conducted.

International Conventions, Treaties and Agreements

Implementation of International Conventions, Treaties and Agreements has been instrumental in sustainable management of natural resources within the NCA. Some of the important ones include the ***Sustainable Development Goals (2016-2030) -*** NCA mandates link very well with the 17 SDGs; ***Treaty for the Establishment of the EAC, Amended in 2007-*** management of NCA strives to preserve the sensitive and variable habitats including wildlife dispersal areas, calving grounds as well as migratory routes and corridors; ***Lusaka Agreement, 1994 -*** Since NCA harbours abundant and diverse species of wild fauna in particular migratory wildlife species, NCA has been controlling potential violations of the Lusaka Agreement provisions; ***Convention on International Trade in Endangered Species of Wild Flora and Fauna, 1973 -*** NCAA has over years strived to set aside enough resources in terms of money and personnel for conducting anti-poaching tasks within and in the vicinity of the Conservation Area in order to ensure that requirements contained in CITES are complied with; and ***Convention on the Protection of International Cultural and Natural Heritages, 1972 -*** Article 4 of this Convention demands State Party to protect, preserve and transmit to future generations of the cultural and natural heritage belonging primarily to that State. In recent years, both habitat goodness and livelihoods inhabitants in NCA have continued to deteriorate. In order to sustain the integrity of the Area, actions, which will either reduce or eliminate impacts that are threatening the outstanding values that made NCA to be inscribed on the list of World Heritage Sites should be embraced.

Others include the ***Convention on Biological Diversity, 1992 -*** any management approach for NCA is dedicated to promoting sustainable development and to becoming a practical tool for translating principles of Agenda 21 into reality. This has to ensure that the area's biological environment including flora, fauna, rare, threatened and endangered species as well as the ecologically sensitive sites, are sustainably

conserved without compromising people's needs such as food, traditional medicines, fresh air, clean and safe water, shelter as well as security from wildlife attacks; The ***Convention on Climate Change, 1992 -*** any future management approach of the Area considers the control of activities that might increase emission gases that are known to contribute to global warming and explore alternative sources of energy to firewood, which is used by all households in NCA for cooking and heating; ***Convention on the Conservation of Migratory Species of Wild Animals*** *(1979)* - whereas NCA habitats support migratory wildlife species of Serengeti Mara Ecosystem (SME), the area also consists of alkaline lakes that attract migratory birds, which any management model to be adopted has to consider the sustainable wellbeing of migratory species both wild animals and birds; and the ***International Plant Protection Convention (IPPC), 1952 -*** Since various construction materials and livestock food supplements will come from outside NCA, which in recent years has caused proliferation of alien plant species and increasingly causing the rangelands to deteriorate, any management approach of the area has to comply with this Convention particularly by instituting close screening on construction materials and livestock food supplements before they are brought inside, strictly prohibiting the introduction of exotic ornamental species and cooperating with relevant stakeholders particularly the indigenous residents to remove any exotic plant species spotted so as to prevent interference with existing indigenous species.

Participatory General Management Plans (GMPs)

The Tanzania Wildlife Legislation requires all wildlife protected areas in the country to have General Management Plans (GMPs) for guiding their management and administration. The first four GMPs, which were developed since NCA was established in 1959 until 1996 were not approved by government for various reasons such as non-involvement of local residents, emphasis on use of compulsion to achieve management goals, plan having many

unmanageable . land-use zones, and plan having not cost effective recommendations. The plans were: Foosbrooke GMP (1960), Eggling GMP (1962), Dirschl GMP (1966), and BRALUP GMP (1982).

The IUCN GMP (1996-2006) which was largely financed by NCAA with coordination done by a Technical Advisor from the International Union for the Conservation of Nature and Natural Resources (IUCN) was the first to be approved and implemented. Two major distinctive qualities, which enabled this GMP to be approved for implementation were; one, active involvement of key stakeholders including the Area's community members, investors in tourism sector, scholars and researchers, conservationists, community development specialists and Non-Governmental Organizations (NGOs), both local and international. Second, the Plan recognized the importance of involving local people in the management of NCA through a representation organ' the Ngorongoro Pastoral Council (NPC).

This GMP delineated five zones, which were believed to be manageable. These were the Ngorongoro Crater, Water Catchment Forest, Short Grass Plains, Livestock Development and Lake Eyasi. Due to archaeological and paleontological importance, the Olduvai Gorge and Amatole Footprints were designated as a sub-zone with its bigger part falling in the short grasslands and smaller one in the Livestock Development zone. Management objectives specific for each of the three components of NCA Multiple Land Use Model namely conservation of natural resources and archaeological treasures, community development and tourism promotion were identified. Management objectives

for administration and operations of the area were also pinpointed in this GMP.

Manongi GMP (2006-2016) on the other hand, set NCAA's vision as self-financed World Heritage Site that provides sustainable benefits for NCA residents and other Tanzanians and guarantees protection of natural, cultural and archaeological resources for global community (NCAA, 2006). The GMP acknowledges that NCAA and indigenous residents have a vested interest in cooperating to achieve the multiple land-use objectives of the area and therefore committing the Authority to promote the development of pastoralists' economy residing therein and strengthening social services to enhance their well-being. Among the objectives, which were stipulated in the GMP included the involvement of indigenous residents in decision making in matters related to conservation, development and tourism, ensuring improved income to NCA residents and ensuring continuous food security.

Important actions, which were recommended for implementation but are not yet implemented or have been partially realized include the natural resources management actions, which are; ensuring that the human, livestock and wildlife populations have access to quality and adequate water resources, developing measures to maintain wildlife corridors and sensitive habitats, developing a building code to preserve the natural scenery of NCA as well as putting in place measures to prevent the introduction of exotic species in the area. Those related to community development were to ensure improved income for NCA indigenous residents by developing a training programme in tourism-related jobs; encouraging their employment by tour

companies; assisting them in tourism-related economic activities and developing non-traditional income generating activities other than tourism.

Others were to; ensure sustainable food distribution programmes and providing reasonable level of price and special subsidies to the poor and destitute families; ensure basic services such as education, health and water supply were provided by co-operating with indigenous residents; control permanent immigration and establishment of unplanned settlements. More actions with respect to community development, which were recommended, included initiating and implementing compensation schemes for legal NCA families willing to resettle outside the area voluntarily, develop birth control strategy to manage high human population growth as well as reducing the incidences of property damage and costs related to wildlife disturbance. It is worth to note that the GMP preparation approach was participatory in nature and involved the local communities and other stakeholders through meetings and workshops.

With regard to tourism, the proposed actions, which have to be implemented include placing a moratorium on any additional lodges, tented camps or other permanent commercial facilities on the Ngorongoro Crater rim, reducing the number of vehicles in Ngorongoro Crater and increasing the number of visitors per vehicle by significantly increasing the fee per vehicle entering into the crater, reducing the number of special campsites at Ndutu and Masek lakes from ten to five and rehabilitating the camping sites and access roads.

Integrating modern rangeland management science with traditional rangeland techniques

Apart from using modern science range management techniques there have been efforts to use more traditional rangeland management techniques and engage local communities in various activities for the control of invasive/alien plants species in NCA. Through the latter, NCAA has for example managed to eradicate *Datura stramonium* at the Crater floor for about 95%. Similarly, through community rangeland committees, efforts have been done to build community capacity by providing study tours to various areas in order promote traditional rangeland management system which is an input to the GMP.

Conclusion and recommendations

As a way forward to sustainably enhance human/wildlife/livestock interaction in rangelands of NCA, stakeholders need to work together and come up with innovative and/or noble ideas. Noble ideas among others should include integration of modern rangeland management and traditional rangeland management systems, participatory rangeland rehabilitation programs including mapping of rangeland resources, destocking, improvement and intensification of rangeland and livestock productivity, infrastructure development, strengthening research and Development, and use of sound environmental policies. The alarming increase of human and livestock population over a limited land area, changing life style of communities, demand for improved livelihood, and technological change demands review of the model so as to achieve a win-win situation.

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