NINA Report 258

The effects of vehicle congestion on the environment – an EIA in the Ngorongoro crater

The Environmental Impact Statement

Julius Nyahongo, Asanterabi Lowassa, Lucas Malugu
Hassan Nkya, Grayson Mwakalebe, Jørn Thomassen,
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Norwegian Institute for Nature Research
Tanzania Wildlife Research Institute

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Abstract

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The Ngorongoro Conservation Area Authority (NCAA) faces a great challenge in managing the vehicle congestion in the Ngorongoro crater. They are in need for an assessment of the present situation and realistic plans for mitigating measures and other management actions. The situation is also dealt with in the revised General Management Plan (GMP) for the Ngorongoro Conservation Area (NCA) (NCAA 2006).

Tanzania Wildlife Research Institute (TAWIRI) and Norwegian Institute for Nature Research (NINA) collaborate on capacity building, of which Environmental Impact Assessment is one of the tasks. In the capacity building programme it has been decided to use a concrete EIA as a training tool.

NCAA, TAWIRI and NINA have decided to use the tourist vehicle congestion in the Ngorongoro Crater as the EIA case in the capacity building programme. Previous reports document the EIA training (Thomassen et al. 2003) and the scoping process (Thomassen et al. 2005). This report, the Environmental Impact Statement (EIS), documents the assessments done, including recommendations and technical reports from the studies conducted.

Important recommendations on management actions include the establishment of a zoning system specifying the number of vehicles allowed in each area per day, differentiated fee systems in NCA, and developing a better education and awareness training programme for NCAA staff and tourist drivers.

Monitoring recommendations include monitoring of densities and distribution of endangered species and carnivores, flight distances of herbivores and occurrence of invasive species and diseases in NCA. Further, it is recommended to monitor the health condition of the Maasai livestock and the carrying capacity of NCA. Visitor satisfaction should be mapped/monitored every 5th year.

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Sammendrag

Nyahongo, J., Lowassa, A., Malugu, L., Nkya, H., Mwakalebe, G., Thomassen, J., Kaltenborn, B. P., Lyamuya, R., Marealle, W., Keyyu, J., Stokke, S. & Røskaft, E. 2007. The effects of congestion of vehicles on the environment – an EIA in the Ngorongoro crater. The Environmental Impact Statement – NINA Report 258. 83 pp.

Forvaltningsmyndighetene i Ngorongorokrater-området (Ngorongoro Conservation Area Authority (NCAA)) i Tanzania står overfor en stor utfordring i forvaltning og regulering av antall kjøretøyer ned i krateret. De trenger en utredning om status og realistiske anbefalinger om ulike forvaltningstiltak. Problemstillingen tas bl.a. opp i den reviderte forvaltningsplanen for området (General Management Plan (GMP)) (NCAA 2006).

Tanzania Wildlife Research Institute (TAWIRI) og Norsk institutt for naturforskning (NINA) har gjennomført et 5 års samarbeidsprogram om kapasitetsbygging. Konsekvensutredninger (KU) er et av temaene i dette programmet, og det ble bestemt at en konkret KU skulle brukes i opplæringen av TAWIRI personell.

I samarbeid med NCAA, valgte TAWIRI og NINA ut den høye konsentrasjonen av kjøretøy i Ngorongoro krateret som KU-case. Tidligere rapporter fra samarbeids-programmet dokumenterer KU opplæringen (Thomassen et al. 2003) og scoping- (målfokuserings-)prosessen (Thomassen et al. 2005). Denne rapporten, KU dokumentet, oppsummerer de vurderingene som er gjort, inklusive anbefalinger og de tekniske rapportene fra undersøkelsene som er gjennomført.

Viktige forvaltningsanbefalinger er bl.a. etablering av et soneringssystem som skal regulere antall kjøretøy tillatt i hvert område i krateret per dag, differensierte parkavgifter i NCA, utvikling av bedre opplæringssystem for utdanning og bevisstgjøring av NCAA-ansatte og turistsjåfører.

Anbefalinger om overvåking inkluderer overvåking av tetthet og fordeling av truete arter og rovdyr, fluktavstanden hos gressetere og forekomst av introduserte arter og sykdom i NCA. Videre er det anbefalt å overvåke sunnhetstilstanden til Maasaienes buskap og bærekraftigheten til NCA. Det anbefales at graden av tilfredshet hos besøkende (turister) til NCA blir kartlagt / overvåket hvert 5. år.

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Contents

Abstract **3**

Sammendrag **4**

Contents **5**

List of acronyms **6**

Foreword **7**

1 Background and challenges **8**
1.1 Background Information 8
1.2 Challenges 10

2 The scoping process and the Terms of Reference **12**
2.1 The scoping process 12
2.2 The Terms of Reference for the EIA study 12
2.2.1 Main objectives for the ToR 12
2.2.2 Studies conducted 13

3 Summary of results **14**
3.1 The Maasai study (VEC 1 Maasai community) 14
3.2 The Tourism study (VEC 2 Tourism) 14
3.3 The Ecological study (VEC 3 Endangered species, Carnivores and Sensitive habitats) 15

4 Assessment of results **16**
4.1 Step by step assessment 16
4.1.1 Step 1 Evaluation of category C hypotheses 16
4.1.2 Step 2 Assessment of impacts significance 18
4.1.3 Step 3 Assessment of effects 19

5 Synthesis of assessments **27**
5.1 Potential impacts 27
5.2 Recommendations 28
5.3 Recommended monitoring and management actions 30

6 References **32**

7 Appendix **33**
7.1 Technical reports from the studies conducted 33
7.1.1 The Maasai study (VEC 1 Maasai community) 33
7.1.2 The Tourism study (VEC 2 Tourism) 42
7.1.3 The Ecological study (VEC Endangered species, VEC Carnivores and VEC Sensitive habitats) 66
7.2 Impact assessment report form 82

List of acronyms

AEAM	Adaptive Environmental Assessment and Management
AWF	African Wildlife Foundation
BHWI	Biodiversity and Human Wildlife Interface
CAWM	College of African Wildlife Management
COSTECH	Tanzania Commission for Science and Technology
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
FZS	Frankfurt Zoological Society
GMP	General Management Plan
GPS	Global Position System
IH	Impact Hypothesis
MNRT	Ministry of Natural Resources and Tourism
NCA	Ngorongoro Conservation Area
NCAA	Ngorongoro Conservation Area Authority
NEMC	National Environment Management Council
NINA	Norwegian Institute for Nature Research
NoI	Notice of Intent
NORAD	The Norwegian Agency for Development Cooperation
NRC	Norwegian Research Council
NTNU	Norwegian University of Science and Technology
Per.distance	Perpendicular distances
SE	Standard Error
TANAPA	Tanzania National Parks
TAWIRI	Tanzania Wildlife Research Institute
ToR	Terms of Reference
UNESCO	United Nations Educational, Scientific and Cultural Organization
UTM	Universal Transverse Mercator
VEC	Valued Ecosystem Component
WD	Wildlife Division
WWF	World Wildlife Fund

Foreword

This publication is part of the reporting from the collaborative programme in capacity building (2002 – 2006) between Tanzania Wildlife Research Institute (TAWIRI) and Norwegian Institute for Nature Research (NINA). One of the targets in this programme is to provide TAWIRI with an overview and a basic knowledge in Environmental Impact Assessment (EIA) to be prepared to conduct EIAs themselves in the future. In April 2002 thirteen staff from TAWIRI, one from Tanzania National Parks (TANAPA) and one from the Ngorongoro Conservation Area Authority (NCAA) attended a five days EIA training course held at Serengeti Wildlife Research Centre (Thomassen et al. 2003).

NCAA, TAWIRI and NINA have decided to use the vehicle congestion in the Ngorongoro Crater as the EIA case in the capacity building programme. This report is the final reporting of the EIA, the Environmental Impact Statement (EIS). It is important to emphasise that this work is not a full EIA, since the main purpose has been capacity building of TAWIRI. Consequently, and due to restricted resources, the EIA focuses on a few, but important, aspects of the vehicle congestion in the Ngorongoro crater.

Nevertheless, the scoping and the assessments done will hopefully give significant and important input to the management of the NCA in the future.

Funding for the capacity building collaborative programme (2002-2006), which includes the EIA work, is provided by NORAD. We will give honour to all the stakeholders participating in the EIA process (representing various stakeholders: Ngorongoro pastoralist council, Tanzania Commission for Science and Technology (COSTECH), Mweka college, NCAA, National Environment Management Council (NEMC), TANAPA, TAWIRI and Wildlife Division (WD), all showing strong willingness to seek new information and assess the potential impacts from vehicle congestion on the ecosystem, including humans in the crater. Tourist questionnaires and semi-structured interviews in the Maasai society have been part of the study, and we will also give great honour to the various respondents contributing significantly to the assessments.

Trondheim, Norway, May 2007

Jørn Thomassen
Julius Nyahongo
Bjørn Petter Kaltenborn

1 Background and challenges

1.1 Background Information

Called the 'Eighth Wonder of the World' and stretching across some 8,292 km², the Ngorongoro Conservation area (NCA) in northern Tanzania boasts a blend of landscapes, wildlife, Maasai people and archaeology that is unsurpassed in Africa (Figure 1 and 2).

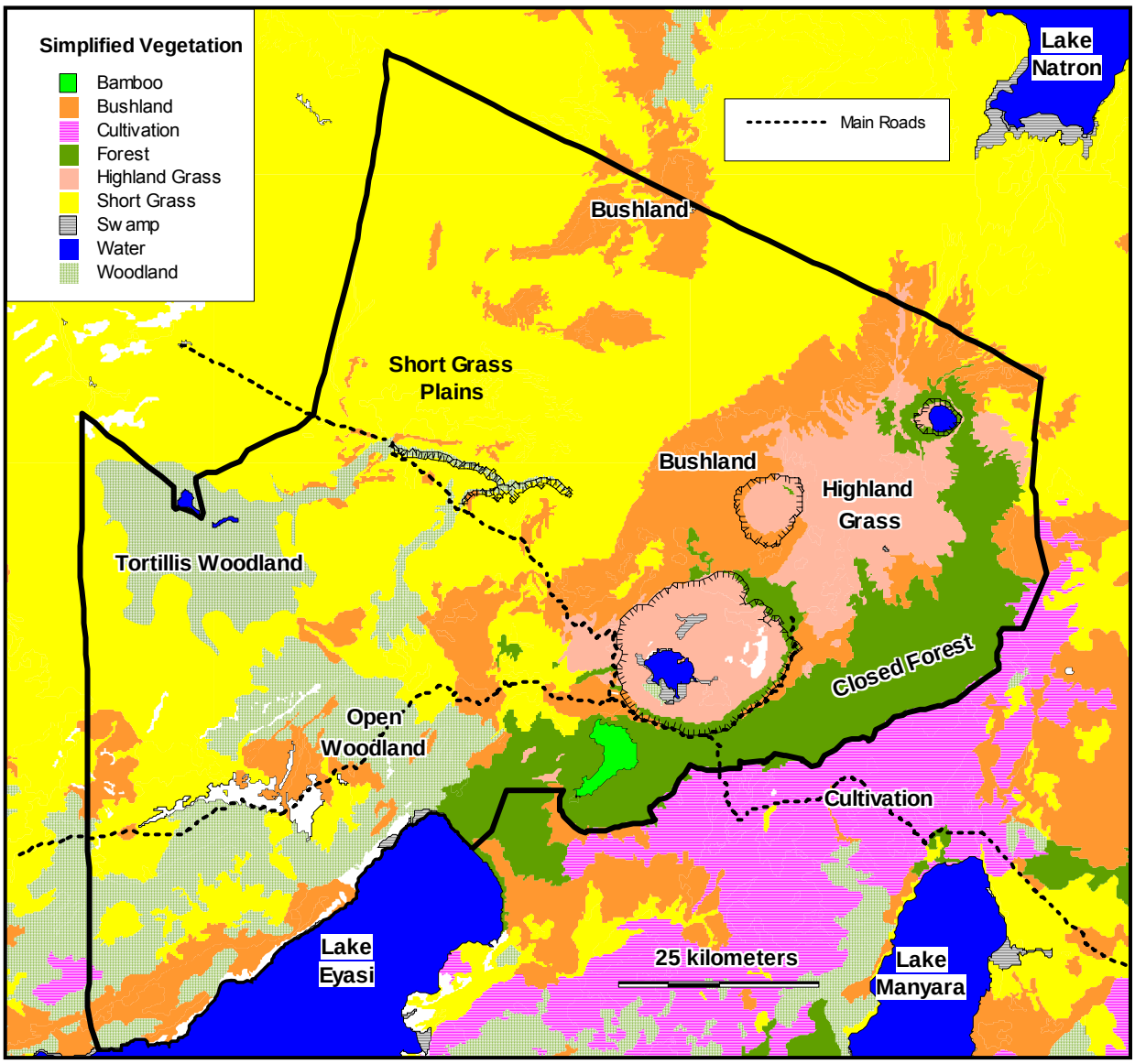

Figure 1. Ngorongoro Crater Area, Tanzania. Simplified vegetation map of NCA (NCA 2006).

The NCA was established in 1959 and at that point it was separated from the Serengeti National Park as a pioneer experiment in developing a multiple land use area with the objective to accommodate the needs of Maasai people who traditionally are pastoralists, and the main residents of the area. Here pastoralism, conservation and tourism coexist in a carefully managed harmony (ole Saibull 1968).

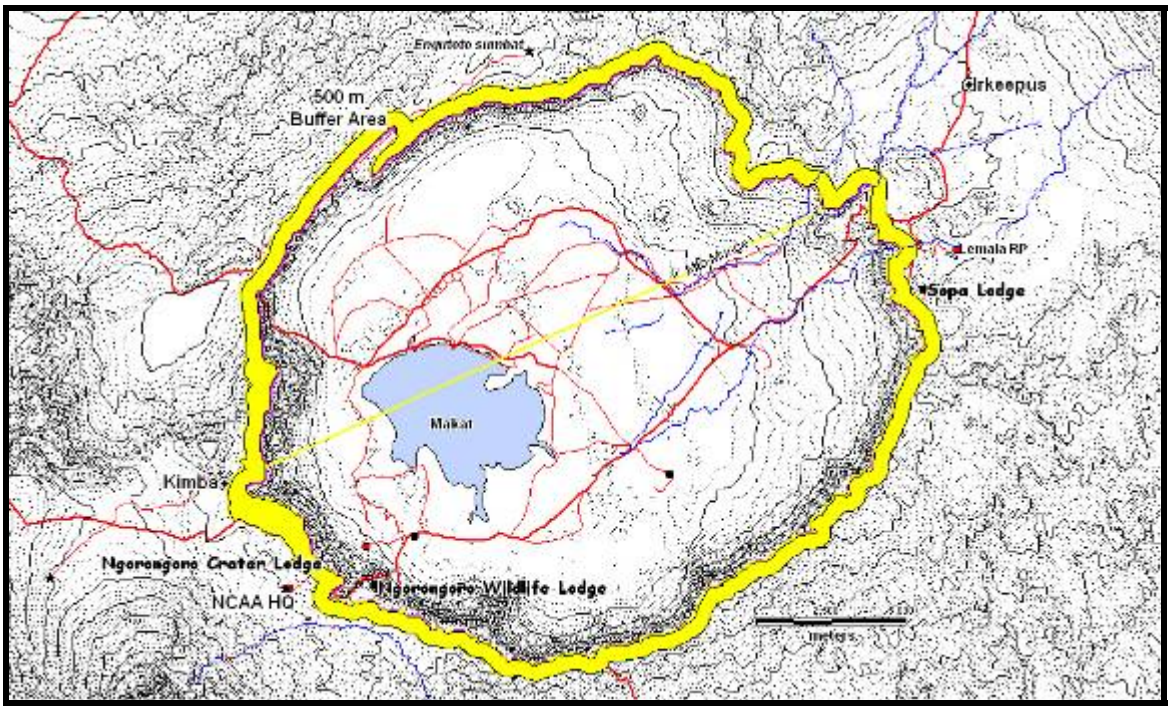

Figure 2. Ngorongoro Crater with sub-zones and roads (NCAA 2006).

Over 300 years ago the Nilo-Hamitic nomadic Datoga tribe are known to have brought their cattle into the mineral rich and permanent watered Crater for better pasture. This tribe were forced out by the incoming Maasai in the early 19th century. This coincided with the attempted settlement by two Germans with the intention to farm in the Crater. These were evicted by Maasai who requently raided their cattle (http://www.ewpnet.com/crater-highland.htm). The Crater and its surrounding area, which became an experiment in multi-purpose land use since it was annexed from the Serengeti National Park, has therefore continued to play an important part in Maasai tradition.

Furthermore, the Ngorongoro Crater and the surrounding areas throughout the early 1900s was visited by hunters as well as people interested in archaeology and film making. This created a need for construction of a few roads and a small hunting lodge on the Crater rim. This magnificent area needed to remain as natural as possible without permanent habitat deterioration; unwarranted increase of human population, livestock and wildlife (ole Saibull 1968). The state of art on how NCA should be administered was clearly defined and accepted by the government of Tanzania by instituting a policy that would look specifically at issues of rights of life and residence of resident Maasai, access to resources, sharing of the benefits accruing from the natural resources in the NCA and participation in decision-making organs to ensure that their interests, needs and aspirations are taken on board (Lissu 2000). The NCA is recognized as the home of the Maasai residents as well as a source of water for the neighbouring areas. It is pledged that it should be conserved and developed in such a way that it may provide a maximum sustained yield of products for the benefit of the humans dependent thereon, without causing deterioration in the habitat and so maintaining the area's unique tourist attraction, aesthetic value and scientific interest (Homewood & Rodgers 1991).

Although the centre piece of NCA is the breath taking Ngorongoro Crater, which is a Caldera covering about 250 square kilometres, the land in the conservation area is a multiple land use unique in Tanzania as the only conservation area, providing protection status for wildlife whilst allowing human habitation. As such, land is controlled to prevent negative effects on the wildlife populations. The Conservation Area also protects Olduvai Gorge and Laetoli footprints at Ngarusi situated in the plains area, which is one of the most important prehistoric sites in the world and has been instrumental in furthering understanding of early human evolution (Leakey 1979).

The Crater is internationally recognized for its rich and easily viewable wildlife and spectacular scenery. It supports high densities of wildlife throughout the year, which includes few numbers of black rhinoceros in the country. These features have attracted many visitors and the NCA has become one of the most visited tourist destinations in Tanzania and the world at large, attracting nearly a half of the tourists visiting the country in 1994 alone. It is because of this outstanding universal value and uniqueness that, UNESCO under the Protection of the World Cultural and Natural Heritage and Man and Biosphere Programme proclaimed the NCA the status of the World Heritage Site in 1979 and classified it as a Biosphere Reserve in 1981, with the principal aim of fostering international cooperation in safeguarding this important area (Lissu 2000).

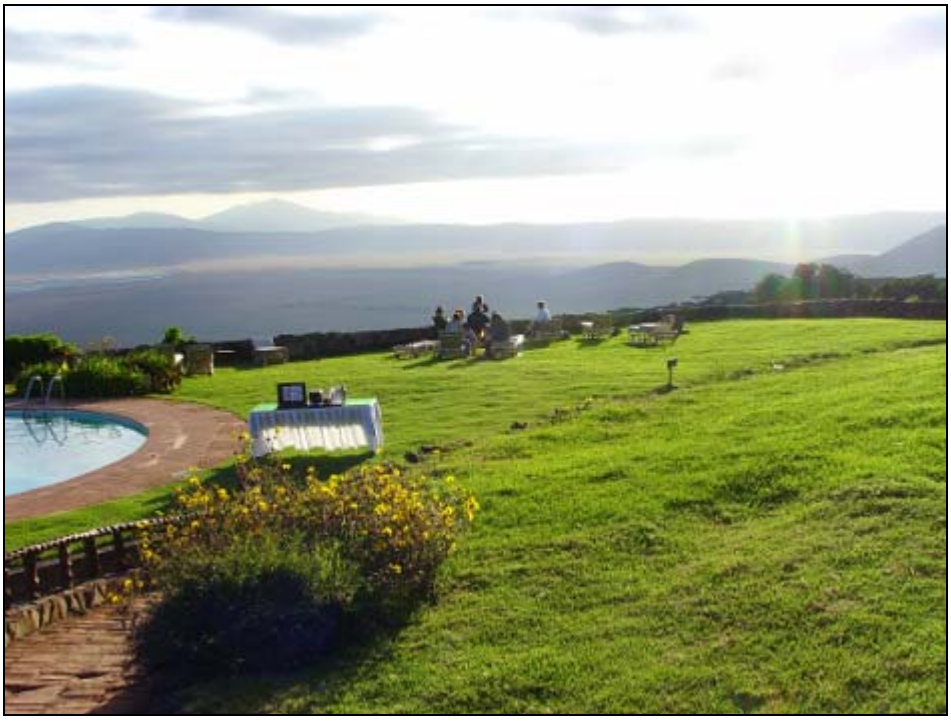

Figure 3. View over the Ngorongoro Crater from one of the tourist lodges – Sopa lodge at the rim (Photo: J. Thomassen).

1.2 Challenges

Tourism industry, just like any other activities, may encounter serious difficulties due to insufficient considerations taken in relationship with the surrounding environment. Based on information collected from tourism department in NCA the data recorded on visitor gate entries to the NCA has risen from 122,791 tourists in 1991 to 234,452 in 2005. According to the NCA General Management Plan (1996) it is reported that the Ngorongoro crater's capacity was approaching the saturation and that any further increase of tourists/visitors would result into destruction of wildlife and environment.

Tourism in NCA is booming leading to considerable increase in revenue, number of tourists and vehicles. Data from Table 1 summarises the number of visitors/vehicles visited Crater from 1997 to 2005, precisely showing a growing pressure of tourists in the Crater.

However, while visitor attractions virtually remain the same in the Crater, there are still some shortcomings and environmental aspects to deal with increased number of vehicles and congestion. The disturbance to animals may affect their behaviour and hence reduce their survivorship or may become tame and thus encounter zoonotic diseases. Once wildlife and their environment are destructed, you get visitors dissatisfaction and drop in tourism revenue, ad-

versely affecting NCA well being and resident Maasai livelihood. This means that it is important to know the maximum permitted visitor use in this magnificent area, so as to balance visitors' satisfaction, resident Maasai needs and sustainable conservation requirements.

Table 1. Visitors and Vehicles to Crater 1996 to 2005 through Lemala and Seneto Gates (Source: NCAA Tourism Office).

Year	Visitors			Vehicles		
	Lemala	Seneto	Total	Lemala	Seneto	Total
1996						
1997	29702	66370	96072	6228	14597	20825
1998	50100	30669	80769	11689	6343	18032
1999	24122	98306	122428	4967	20873	25840
2000	30639	108926	139565	6520	23603	30123
2001	31001	100151	131152	6410	23697	30107
2002	30821	121759	152580	6263	24645	30908
2003	29505	127136	156641	6373	30306	36679
2004	46758	156049	202627	9392	31133	40525
2005	51155	183297	234452	10613	37644	48257

This situation of increased congestion of vehicles in the Ngorongoro crater has raised a big concern and NCAA showed the need for an Environmental Impact Assessment (EIA) in the Crater.

However, before undertaking any EIA, there are a limited number of issues to be addressed by a scoping process (Beanlands 1988). This is usually the first stage in the assessment process where an institution solicits stakeholders' input to get a general understanding of major resource issues and management concerns, so as to enable the institution to issue a Notice of Intent (NoI) thus signalling the start of the formal EIA. The process normally include considerations of impact factors and potential impacts, decision makers, stakeholders, alternatives, access of baseline information, time schedule and economic frames (Thomassen et al. 2003).

Figure 4. Tourist vehicle congestion at the picnic site in the Ngorongoro crater (Photo: J. Thomassen).

2 The scoping process and the Terms of Reference

2.1 The scoping process

The main scoping was conducted at the Karatu workshop (11. – 15. October 2004). The scoping approach and process, results, conclusions and recommendations, including the Terms of Reference (ToR) for the EIA study, are documented in the scoping report (Thomassen et al. 2005). A brief summary is given below:

Participatory approach. The Adaptive Environmental Assessment and Management (AEAM) (Holling et al. 1978) approach was used in the scoping process. AEAM is a participatory workshop based method where important stakeholders attend. Through several group works, the overall picture is reduced to the most significant important impact factors and focal issues to be addressed in the EIA study. The process is systematically and well documented in all steps towards the terms of reference for the EIA study.

Main scoping results. Central concepts in the AEAM approach is impact factors, focal components named Valued Ecosystem Components (VECs), schematic flow charts, impact hypotheses (IHs) and recommendations. Out of 13 impact factors assessed, 6 were given priority. 24 Valued Ecosystem Components (VECs) were assessed, 9 were given priority. For each of the VECs a schematic flow chart was constructed and a number of impact hypotheses were formulated and evaluated for each of the VECs.

Additional scoping. Due to limited resources for conducting a full EIA study and the fact that the main purpose for this study has been capacity building for TAWIRI, further scoping was necessary subsequent to the Karatu workshop. An expert group consisting of representatives from MNRT, TAWIRI and NINA did an additional scoping in Trondheim, Norway in November 2004. The number of VECs were reduced and/or combined from 9 to 2 VECs, namely: *A. Human aspects (analysis of tourism issues and the Maasai community, related to EIA);* and *B. Ecological aspects (analysis of vehicle impacts on endangered species, carnivores and sensitive habitats)*. For each issue objectives, outputs, activities, budget, time frame and staffing were proposed.

The main purpose of the scoping process is to focus on the most important issues to be addressed in the EIA study. The AEAM scoping approach results in a restricted number of VECs with corresponding impact hypotheses. The evaluation procedure of the impact hypotheses put the hypotheses into one out of four categories: A. Not valid; B. Valid; C: Possible valid, but more information needed; and D: Possible valid, but not worth testing (see scoping report for more details, Thomassen et al. 2005). For the category C hypotheses more information is needed to validate or invalidate the IH, which has been the main purpose of the recommended studies in the ToR.

2.2 The Terms of Reference for the EIA study

2.2.1 Main objectives for the ToR

Human aspects. To conduct a study among visitors to Ngorongoro Crater with special focus on visitor experience and satisfaction, as well as perception of environmental conditions and impacts. It will also include a qualitative study of perceptions of tourism in the Maasai community.
Ecological aspects. To conduct a study of the impact of tourism on endangered animal species and sensitive habitats in the Ngorongoro Crater. The study will focus on large carnivores, elephants and rhinos and their reactions to variable levels of tourist influx. The quality of water reservoirs will be monitored in relation to tourism activity and precipitation.

2.2.2 Studies conducted

Three studies were carried out as summarized below (see appendix for technical reports):

Tourism study
The study area (NCA) was visited in different occasions since 2004.This study was carried out in the Ngorongoro crater at a picnic site. About 400 tourists were interviewed using a questionnaire. The interview was conducted during lunchtime at Ngoitokitoki spring where many tourists prefer to take their lunch. Before interviewing the tourists, researcher explained to tour guide and drivers the aim of the study and requested drivers/tour guide to ask tourists to fill the questionnaires (self-interview).

Impact of Tourism to Maasai of Ngorongoro Conservation Area
The study was conducted in the Ngorongoro Conservation Area in northern Tanzania. Five villages and three cultural bomas located close to the Crater but along tourist circuit were chosen. These villages were Meshili, Oloirobi, Emisigio, Erkipus and Nainokanoka and cultural Bomas were Elerai, Seneto and Loongoku. In each village a sample of about 10-12 people were chosen for focus group discussion, using a checklist of questions. Data collection was carried in two phases: focus group discussion was carried out in February 2006 and house hold survey where a sample of 150 respondents 30 from each village were interviewed in November 2006. The study intended to involve females and males from different age groups with exclusion of young children below the age of 18 years.

Ecological study
An assessment at different levels of tourists and wildlife resources interactions was carried out with the objectives of providing current information on animal ecological aspect in relation to tourism aspects. Distance sampling approach technique was used to estimate density and abundance of animal species observed along the seven transects (Lerai forest, Odonyo Rumbe, Engitati hill, Seneto, Ngoitoktok spring, Munge river, Alayanai hill) with a total distance coverage of 37 km. The same approach was used to get an impression of the degree of animal avoidance (or eventually attraction) from tourist roads. Direct observation was used to study animal responses when tourists approached/congested them.

3 Summary of results

See appendix 7.1 for technical reports from the studies.

3.1 The Maasai study (VEC 1 Maasai community)

Results from household survey indicated that between 86-100% of all respondents interviewed in the five villages were well aware and understands the benefits accrued directly or indirectly from tourism industry. First and foremost a certain percentage of money accrued from tourism by NCA is channelled to Maasai Community primarily to assist developmental activities, such as education, food security, income generating activities, health and veterinary services. However, some negative impacts emanating from tourism like incidences of environmental pollution were cited in Erkipus and Nainokanoka villages particularly uncontrolled disposal of plastic bags and foil papers that are known to be damaging to livestock and wildlife. Maasai were in favour of the area to continue being conserved (12-19%).

Further studies were suggested to ensure that the influx of tourists and subsequent vehicle congestion compromise with visitors' satisfaction, tourism development and the environment conservation.

3.2 The Tourism study (VEC 2 Tourism)

The study hypothesed that, increased traffic volume will cause destruction of environment in the crater and degrade the tourism attractions leading to reduction in number of tourists.

The tourism study supports this. For instance, about 60% of respondents interviewed (N = 400 respondents) claimed that there was vehicles congestion in the crater. Moreover, 72.5% (N = 400 respondents) of all respondents interviewed would not visit Ngorongoro if the number of tourists in the park were doubled. Furthermore, when the tourists were requested to express their opinion about the effect of tourism on the environment in NCA, 73.9% of respondents (N = 400 respondents) claimed that tourist vehicles have negative impact to NCA environment.

The tourism study recommended the following measures and actions:

- Alternative transport system should be designed to fit into the natural setting of NCA; and this will improve the visitors experience and satisfaction as well as protecting park resources from degradation including wildlife and other natural resources.
- To diversify visitors to other attractive site within NCA; Empakai crater, Olmooti crater etc.
- Introduction of shifting and new booking system whereby a number of recommended visitors entering the crater shift will be maintained.
- To educate tour guides and drivers about the rules, regulations and other park resource ecology so that to recommend and diversify visitors to go to other places than in the crater only.
- Tourist numbers and satisfaction should be monitored and evaluated after every five years.
- Fee partitioning; high in the crater and low in other areas.
- Fund for detailed studies relating to vehicle congestion to the crater ecology should be availed.

3.3 The Ecological study (VEC 3 Endangered species, Carnivores and Sensitive habitats)

In general animals exhibited a tendency of avoiding staying close to the roads in the crater as the probability of detecting an animal more than 100m away from the road was higher than the probability of detecting an animal closer to the road. Carnivore behaviour predominantly exhibited as either walking or running, as this tally with an assumption that animals start moving from their initial position when they sense an approaching vehicle. Lions and cheetahs were some times observed moving away from congesting/approaching vehicles, suggesting that they might respond by trying to avoid heavy traffic. This might affect the activity budget of the carnivores and hence interfere with their hunting success and feeding rates. There is no evidence suggesting that tourism have affected the population sizes of ungulates and carnivores in the crater as abundance numbers largely were comparable with earlier records, except for warthog and ostrich which seem to have increased.

Recommendations:

- There is a need to conduct regular monitoring of the animal populations in the crater (to enable predictions of long term population developments) to assess more firmly possible impacts of tourism activities on the environment, ecology and health of the habitat and animal community.
- NCAA should (on a regular basis) inform stakeholders, tour operators and hotel companies about ecological effects of tourist activities on sensitive habitats and endangered species.
- There should be a call for a NCAA management strategy to channel and control the number of tourist vehicles entering the crater per day and the amount of time spent per sighted carnivore surrounded by vehicles.
- NCAA should consider to minimize activities near sensitive areas such as Ngoitoktok spring and Lerai forest
- NCAA should provide closed lavatory and disposal systems and measures to mitigate spread of zoonotic diseases

4 Assessment of results

Focus has been put on two main interrelated issues: Human aspects and ecological aspects. Human aspects consist of two VEC's: **VEC 1: Maasai community** and **VEC 2: Tourism**. Ecological aspects consisted of three VEC's (given priority in the scoping process, see Thomassen et al. 2005). Since the hypotheses and challenges were quite similar for these VEC's we have merged them into one: **VEC 3: Endangered species, Carnivores and Sensitive habitats**.

For each of the VEC's a number of impact hypotheses have been formulated and evaluated. The main purpose of the investigations conducted have been to collect new information for validation of category C-hypotheses (possible valid, but more information is needed), in addition to get a better fundament for mitigating measures. A step by step procedure has been used in the assessment of potential effects.

1. Evaluation of category C hypotheses by applying results from the EIA investigations
2. Assessment of impacts significance
3. Assessment of effects

4.1 Step by step assessment

4.1.1 Step 1 Evaluation of category C hypotheses

Based on the investigations on human aspects, on ecological aspects and on literature, the significance of the **C hypotheses** were assessed (Table 2). If found valid the category will change to B (valid), if not it can either be changed to A (invalid) or still be in C with recommendations on further research or other investigations. **Outcome**: A number of **B hypotheses** (valid) to be used in the assessment of impacts, and recommendations on further investigations.

Table 2. Assessments of impact hypotheses

VEC 1: Maasai community				
IH no.	**Impact hypothesis**	**category**		**Investigation findings** *)
		old	**new**	
1-1	Traffic overuse in the crater will change the socio-cultural values of the Maasai community	B	**B**	This is verified in a study by Paul Fisoo (2001) Recent study supports earlier findings. Some negative effects in a few, restricted locations. Mostly very few/minor negative specific effects. Some long term positive effects through education opportunities funded by tourism revenues.
Conclusions: The hypothesis is already assessed to be valid.				
1-2	Invasion of exotic plants will cause change in land use patterns among the Maasai community.	D	**D**	May be valid, but investigations to validate the IH assessed to be too expensive and impractical for this EIA study.
Conclusions: Category D hypothesis				
1-3	Increased livestock mortality will reduce income of the Maasai community	C	**B**	Valid, but its difficult to assess if tourism activities lead to or affect disease situation directly. Connectivity is difficult to ascertain
Conclusions: This problem will be mentioned under recommendations				
1-4	Increased tourism in NCA will improve the income of the Maasai community	B	**B**	Communities receive economic benefits, and individuals benefit indirectly. Need to compare livestock economics with tourism dynamics and economics
Conclusions: The hypothesis is already assessed to be valid.				

VEC 2: Tourism				
IH no.	**Impact hypothesis**	**Category**		**Investigation findings** *)
		old	**new**	
2-1	Increased traffic volume will cause destruction of environment in the crater and degrade the tourism attractions leading to reduction in number of tourists	C	**B**	EIA study supports this. Majority of tourists perceive amount of traffic as detrimental to visitor experience, and 72.5 % would not revisit to the Crater if number of tourists double.
Conclusions: Research findings verify hypothesis, change from C to B				
2-2	The outbreak of diseases will lead to decline in number of tourists in the crater	C	**B**	Outbreak of diseases can affect tourism in different ways and for different reasons. Outbreak of anthrax in Serengeti 2000 scared tourists. Many factors affect perceptions, some related to human safety, others to quality of visitor experience and likelihood of encountering animals. All disease outbreaks are potentially negative, but further research is needed to understand this better. EIA study shows that 65.8% of tourists in the Crater would not visit again if wildlife populations were reduced by 50%.
Conclusions: Research findings verify hypothesis, change from C to B				
2-3	Appropriate policy framework sets enabling environment for quality tourism	C	**C**	Policy settings and frameworks are always important for management and tourism development, but for various reasons remains beyond the scope of this project.
Conclusions: Remains a C hypothesis since the question requires further studies and analysis.				
VEC 3: Endangered species, Carnivores and Sensitive habitats				
IH no.	**Impact hypothesis**	**Category**		**Investigation findings** *)
		old	**new**	
3-1	Congestion of tourist vehicles may affect the activity pattern of endangered species *(Endangered species)*	C	**B**	EIA research findings (direct observation) document significant changes in behavioural patterns for cheetah, lion and rhino caused by approaching tourism vehicles in various locations in the Crater.
Conclusions: Research findings verify hypothesis, change from C to B				
3-2	Increased congestion of tourist vehicles reduces hunting success per unit effort spent by carnivore. *(Carnivores)*	C	**B**	EIA research findings document (direct observation) as well as the Serengeti cheetah project that tourism vehicles approaching interfere with and distract the hunting patterns of cheetah.
Conclusions: Research findings verify hypothesis, change from C to B				
3-3	Spread of zoonotic diseases may be influenced by congestion of tourist vehicles at the picnic sites and thus affect carnivores direct and indirect. *(Carnivores)*	C	**C**	This is highly likely, but the required research has not been carried out yet. Observation of tourists feeding birds have been observed, but possible effects have not been measured or identified
Conclusions: Remains a C hypothesis since the question requires further studies and analysis.				
3-4	Congestion of tourist vehicles at a kill may elevate the feeding time of the carnivores increasing inter and intraspecific competition. *(Carnivores)*	C	**C**	General, but unsystematic observation suggest this is the case, but the interaction needs to be properly investigated. Differences in responses among species should be expected.
Conclusions: : Remains a C hypothesis since the question requires further studies and analysis				
3-5	Soil erosion will cause siltation of water bodies leading to alteration of water quality and quantity	C	**C**	General knowledge from other studies and areas suggest a relationship between amount of traffic and erosion and siltation, but this has not been investigated in the Crater.
Conclusions: : Remains a C hypothesis since the question requires further studies and analysis				

***) Literature and investigations conducted for this particular EIA**

4.1.2 Step 2 Assessment of impacts significance

Each of the valid hypotheses (category B) (and C if insufficient information for validation) were assessed through an assessment system (see appendix for more information about the assessment system), first through an assessment of impact dependent factors (1) and then through an assessment of impacts significance (2) using three scale parameters: time, space and impact magnitude. **Outcome**: potential impacts on three levels: low, medium and large. Assessment of impact significance is summarised in Table 3 .

Table 3. Assessment of impact significance on the VEC Maasai community, VEC tourism, and VEC Endangered species, Carnivores and Sensitive habitats in the Ngorongoro Conservation Area. The potential impact level is based on an assessment of three scale parameters, namely spatial scale, temporal scale and impact magnitude (rationale).

Impact factor	Impact hypothesis	Impact level (score)	Rationale
VEC 1 Maasai community			
Traffic overuse	1-1 Traffic overuse in the crater will change the socio-cultural values of the Maasai community (B)	Medium negative (9)	**Spatial**: Changes in socio-cultural values of Maasai community due to overuse by traffic in the Crater may affect the cultural tourism **Temporal**: Any change in socio-cultural values of any human kind is irreversible **Impact magnitude**: Maasai community may change their lifestyle
Invasive species	1-2 Invasion of exotic plants will cause change in land use patterns among the Maasai community (D)	NA	Category D
Diseases	1-3 Increased livestock mortality will reduce income of the Maasai community (B)	Medium negative (9)	**Spatial**: Maasai community livelihood depend on livestock. Thus livestock mortality will reduce the income in turn affecting the livelihood. **Temporal**: In long term Maasai community will depend on government subsidies. **Impact magnitude**: More funds that will be used for other development activities will be channelled to support Maasai communities thereby jeopardizing the chances of other development projects.
Increased tourism	1-4 Increased tourism in NCA will improve the income of the Maasai community (B)	High positive (27)	**Spatial:** Improved Maasai income in NCA will relieve the government financial support and divert the funds to other Maasai development activities. **Temporal:** Income generated from tourism industry will improve the Maasai livelihood in the long term (generations). **Impact magnitude:** By experience world wide slow increase in income has improved livelihood and never reverse (people never go back)
VEC 2 Tourism			
Increased traffic overuse	2-1 Increased traffic volume will cause destruction of environment in the crater and degrade the tourism attractions leading to reduction in number of tourists (B)	High negative (27)	**Spatial:** NCA is a world heritage site and biosphere reserve; hence degradation of this area will affect both national and international tourism. **Temporal:** Natural and artificial restoration of degraded environment is expensive and takes long time if at all possible. **Impact magnitude**: Natural environment that has reached climax succession takes long time to recover when degraded.
Spread of diseases	2-2 The outbreak of diseases will lead to decline in number of tourists in the crater (B)	Medium negative (9)	**Spatial:** Outbreak of **s**ome diseases like bird flue will affect both domestic and international tourism but some diseases like anthrax will only have local impact. **Temporal:** Most of wildlife disease outbreak is often controlled within short period of time.

			Impact magnitude: There will be a rapid reaction from both tourists and wildlife managers.
Policy	2-3 Appropriate policy framework sets enabling environment for quality tourism (C)	High positive(27)	Self explanatory
VEC 3 Endangered species, Carnivores and Sensitive habitats			
Traffic overuse	3-1 Congestion of tourist vehicles may affect the activity pattern of endangered species (B) *(Endangered species)*	High negative (27)	**Spatial:** Endangered species are of international concern. **Temporal:** Any change in animal activity pattern (behaviour) takes generations to restore. **Impact magnitude:** Change in animal activity pattern (behaviour) takes generations to restore.
Disturbance	3-2 Increased congestion of tourist vehicles reduces hunting success per unit effort spent by carnivore (B) *(Carnivores)*	High negative (27)	**Spatial:** Carnivores are attraction to tourists; hence increased congestion of tourist vehicles affects hunting and breeding behaviour that may affect the population negatively. Moreover endangered species are of international concern. **Temporal:** Any change in animal behaviour takes generations to restore. **Impact magnitude:** Change in animal behaviour takes generations to restore.
Spread of diseases	3-3 Spread of zoonotic diseases can be influenced by congestion of tourist vehicles at the picnic sites and thus affect carnivores direct and indirect (C) *(Carnivores)*	High negative (27)	**Spatial:** Outbreak of **s**ome diseases like bird flue will affect both domestic and international tourism but some diseases like anthrax will only have local impact. **Temporal:** Most of wildlife disease outbreak is often controlled within short period of time. **Impact magnitude**: There will be a rapid reaction from both tourists and wildlife managers.
Disturbance	3-4 Congestion of tourist vehicles at a kill may elevate the feeding time of the carnivores increasing inter and intraspecific competition *(Carnivores)* (C)	High negative (27)	**Spatial:** Carnivores are attraction to tourists; hence increased congestion of tourist vehicles may affect hunting and breeding behaviour that may affect the population negatively. More over endangered species are of international concern. **Temporal:** Any change in animal behaviour takes generations to restore. **Impact magnitude:** Change in animal behaviour takes generations to restore.
Traffic overuse/off-road driving	3-5 Soil erosion will cause siltation of water bodies leading to alteration of water quality and quantity (C)	High negative (27)	**Spatial:** NCA is world heritage and biosphere reserve. Any alteration of water quality and quantity may affect wildlife. **Temporal:** Long term processes to restore. **Impact magnitude:** NCA is world heritage and biosphere reserve. Any alteration of water quality and quantity may affect wildlife.

Hypothesis 3-1, 3-2, 3-3 and 3-4 are also valid for the VEC tourism.

4.1.3 Step 3 Assessment of effects

Based on step 1 and 2 above the EIA team assessed potential effects from the congestion of tourist vehicles in the Ngorongoro crater (Table 4). **Outcome**: Assessed direct, indirect and cumulative impacts, and recommendations.

Table 4. Summary table of the assessments of potential impacts, potential effects and recommendations concerning the VEC Maasai community, VEC tourism, and VEC Endangered species, Carnivores and Sensitive habitats in the Ngorongoro Conservation Area.

VEC 1: Maasai Community								
Impact Factor	**Impact Hypothesis**	**Category**	**Period**	**Spatial**	**Temporal**	**Impact magnitude**	**Score**	**Impact level**
Traffic overuse	1-1 Traffic overuse in the crater will change the socio-cultural values of the Maasai community	B	January-December	3	3	3	27	High positive
Consequences:					**Remarks**			
Direct effects and their significance. Increased income and purchasing power								
Indirect effects and their significance: Reduction on reliance on government and donor agency funding as well as reliance on livestock as a core economic activity								
Cumulative effects and their significance: Improved livelihoods and reduced poverty								
Other comments: Improved education levels among Maasai may lead to higher conflict levels between Maasai pastoral lifestyles and conservation as Maasai livelihoods and lifestyles evolve and modernize. At the same time, experiences from other cultures indicate that when education levels and knowledge increases conflict levels may be reduced. This situation is dependent upon a complexity of factors and social dynamics.								
Conclusions VEC: Increased tourism in NCA will improve Maasai livelihoods. However this should be taken with care not to jeopardise the necessary and delicate balance between tourism, environment and Maasai livelihoods**.**								
Recommendations VEC: **Research:** **1)** Conduct a GAP analysis to identify the deficiencies in the current policy situation as regards management of tourism in the NCA. **2)** Assess the relevance of lesson learned in other multiple use and co-management settings of other protected areas for future management of NCA. **Monitoring:** **1)** Monitoring program on the links between tourism industry and activities, the natural environment and the Maasai livelihoods as input to development of management strategies and mitigating measures								
Impact Factor	**Impact Hypothesis**	**Category**	**Period**	**Spatial**	**Temporal**	**Impact magnitude**	**Score**	**Impact level**
Invasive species	1-2 Invasion of exotic plants will cause change in land use patterns among the Maasai community.	D						
Consequences:					**Remarks**			
Direct effects and their significance:								
Indirect effects and their significance:								
Cumulative effects and their significance								
Other comments:								
Conclusions VEC: Category D								
Recommendations VEC: **Monitoring:** Long term monitoring program to determine the effects of invasive species**.**								
Impact Factor	**Impact Hypothesis**	**Category**	**Period**	**Spatial**	**Temporal**	**Impact magnitude**	**Score**	**Impact level**
Diseases	1-3 Increased livestock mortality will reduce income of the Maasai community	B	January-December	1	3	3	9	Medium negative
Consequences:					**Remarks**			
Direct effects and their significance: Loss of livestock and source of income								
Indirect effects and their significance: Other development activities will be deprived of funds that otherwise is channelled to support								

the Maasai community.	
Cumulative effects and their significance: Increased poverty and economic marginalisation	
Other comments:	
Conclusions VEC: Livestock mortality may affect Maasai livelihoods negatively and thus increase the burden on government institutions.	
Recommendations VEC: **Monitoring:** **1)** Extension services in the NCA should be provided to monitor the condition and health status of livestock as well as carrying capacity of NCA.	

Impact Factor	Impact Hypothesis	Cate-gory	Period	Spa-tial	Tem-poral	Impact magni-tude	Score	Impact level
In-creased tourism	1-4 Increased tourism in NCA will improve the income of Maasai com-munity	B	January-December	3	3	3	27	High positive

Consequences:	Remarks
Direct effects and their significance: Increased income to Maasai community	Increased income might increase ru-ral-urban migration. Urban emigration might reduce human activities in NCA.
Indirect effects and their significance: Increased income will im-prove life standard, i.e. good education, health, houses, emigration. Reduced government and donors dependency. Reduced reliance on livestock as the core economic activity.	Stimulation of other income generating activities other than livestock keeping.
Cumulative effects and their significance: Reduction of livestock number hence low livestock-wildlife competition**.**	Natural restoration enhanced.
Other comments: Good education to Maasai community may escalate conflict on the right of resource owner-ship	
Literature: Shivji & Kapinga (1994)	
Conclusions VEC: Increased tourism in NCA will improve Maasai livelihoods. However, this should be taken with care not to jeopardise the necessary and delicate balance between tourism, environment and Maasai live-lihood.	
Recommendations VEC: **Research:** In depth study on the interaction between tourists, Maasai community and environment.	

VEC: Tourism

Impact Factor	Impact Hypothesis	Cate-gory	Period	Spa-tial	Tem-poral	Impact magni-tude	Score	Impact level
Traffic overuse	2.1 Increased traffic volume will cause deg-radation of environment in the crater and de-grade the tourism at-traction leading to re-duction in number of tourists.	B	January-June	3	3	3	27	High negative

Consequences:	Remarks
Direct effects and their significance: Reduction in tourist visits to the Crater.	NCAA might need fund from the gov-ernment for the running of the institu-tion.
Indirect effects and their significance: Reduced revenue to NCA and national GDP. Administrative activities, environmental conserva-tion measures and Maasai livelihoods will suffer from less funding generated by tourism.	Reduction in revenue may affect anti-poaching activities and morale of rangers and other NCAA employees, who might collaborate with poachers.
Cumulative effects and their significance: Reduction in tourist number and subsequent reduction in revenue will lead government to increased subvention to Maasai community, jeopardising other devel-opment activities in other areas. Maasai community may demand the change in land use policy i.e. being allowed to cultivate both subsis-tence and cash crops.	No incentive for emigration from NCA. Ultimately the NCA may loose its cur-rent international recognition.
Other comments: Degraded environment will affect the ecological functions and services of the area hence affecting both flora and fauna of the area, and ultimately the visitor experiences.	
Literature:	

Conclusions VEC: The current congestion of vehicles in the Crater does have negative effects on the tourism visitor experience.

Recommendations VEC:
Research: The hypothesis is assumed to be valid. However, for designing management actions like zoning schemes and vehicle regulations it is recommended to carry out additional research to study specific issues related to vehicle disturbance:
1) Compile existing information from NCA and comparable areas on limits of acceptable change standards related to visitor experiences
2) Study to determine optimal sustainable use levels from a tourism visitor experience perspective
(cfr. Research suggested for VEC Endangered Species, Carnivores and Sensitive Habitats)

Monitoring:
1) Visitor satisfaction should be monitored every 5 years

Management actions:
Management actions for tourism should be assessed in line with recommendations made for VEC Endangered species, Carnivores and Sensitive habitats
1) : Set standards for the maximum numbers of tourist vehicles accepted close to endangered species (based on research) which must be communicated to tour drivers (standards may vary with season
2) Establish a zoning system specifying the number of vehicles allowed in each area per day (standards may vary with season, cfr. Research no. 1 under VEC Endangered species)..
3) Differentiated fee system in NCA i.e. high in the crater and low in other areas.
4) Develop and implement a code of conduct for tour driver, including rules for how to approach animals, how to park and remain at a site, amount of time allowed to remain at a site and how to inform and communicate with the tourists, etc.
5) Develop an environmental education and awareness training program by NCAA for the tour drivers.
6) Consider expansion of purpose and activities of the tourist information centre at entrance in order to systematically informing visitors entering NCA about environmental issues and appropriate behaviour within the protected area. Information must be available in several languages (cfr. Proposal in Draft GMP for NCA 2006).

Impact Factor	Impact Hypothesis	Category	Period	Spatial	Temporal	Impact magnitude	Score	Impact level
Outbreak of wildlife diseases	2-2 The outbreak of wildlife diseases will lead to decline in number of tourists in the crater.	B	January-December	3	1	3	9	Medium (negative)

Consequences:	Remarks
Direct effects and their significance: Reduction in revenue collected from tourist industry.	
Indirect effects and their significance: The government will spend more funds for controlling the disease outbreak jeopardising other developmental activities. NCA will require additional government support to compensate for loss of tourism revenue	This may be dangerous to NCA staff, Maasai communities and visitors if it is zoonotic.
Cumulative effects and their significance: It might be considered by foreign tourists that this is due to poor management and negligence of conservators and thus affect international tourism. The ecological balance may be disrupted if certain species are highly affected.	This could upset the balance between herbivores and carnivores with potentially harmful effects to the overall environment.

Other comments:

Literature: GMP NCA

Conclusions VEC: More frequent outbreaks could affect the local and international tourism in the long term.

Recommendations VEC:
Monitoring: Long term monitoring of wildlife diseases in NCA.
Management:
1) Strengthening veterinary services at NCAA
2) Assess the need for rules governing how close tourists can approach wildlife
3) Strengthen the enforcement of rules for how picnic sites shall be used, i.e. avoid tourists walking outside permitted area.
4) Increase the training of NCAA staff on basic wildlife health and diseases

Impact Factor	Impact Hypothesis	Category	Period	Spatial	Temporal	Impact magnitude	Score	Impact level
Appro-	2-3 Appropriate policy	C	January-	3	3	3	27	High

priate policy	framework sets enabling environment for quality tourism		December					positive

Consequences:	Remarks
Direct effects and their significance: Poor policy will affect revenue, tourists, wildlife and environment**.** A coherent policy situation will facilitate tourism development and biodiversity conservation and sustainability considerations.	High or low fee may influence the number of tourists in NCA thus affecting tourism. Also, high number of tourists due to low fee may degrade the environment leading to visitor frustration. Furthermore, high congestion of vehicles at picnic sites may affect wildlife and tourist satisfaction.
Indirect effects and their significance: Reduced visitation will lead to reduction in revenue collection. A fragmented policy framework makes it complicated to assess carrying capacities, ecosystem services, as well as appropriate activities and use levels.	If policy is more favourable towards tourism development in another area or another country, tourists may decide to visit those areas (displacement effect)
Cumulative effects and their significance: The policy framework is of great importance for the overall social and environmental conditions in the NCA. Some of the policies formulated may reflect prioritisation of certain values which lead to specific management strategies. This can affect Maasai livelihoods, NCA administrative activities and national GDP in different ways.	

Other comments:

Conclusions VEC: A coherent policy framework is crucial for the management, development and sustainability of NCA and subsequently for the viability of the tourism industry operating in the area.

Recommendations VEC:
Research: GAP analysis of policy setting to validate hypothesis and the statements above
Monitoring: Monitoring of social conditions, tourism patterns and ecological conditions are critical inputs to policy development.
Management: Periodic reviews of existing policy to improve the conservation status and community livelihoods.

VEC 3 Endangered species, Carnivores and Sensitive habitats

Impact Factor	Impact Hypothesis	Cate-gory	Period	Spa-tial	Tem-poral	Impact magni-tude	Score	Impact level
Conges-tion of tourist vehicles	3-1 Increased conges-tion of tourist vehicles may affect the activity pattern of endangered species.	B	June-November	3	3	3	27	High negative

Consequences:	Remarks
Direct effects and their significance: Endangered species may reduce their feeding and breeding activities due to disturbance from tourism vehicles. This will reduce the health and viability of the populations.	Most endangered species are also sensitive animals. Most levels of disturbance could have negative effects on populations.
Indirect effects and their significance: Tourists may fail to locate the endangered species that may reduce the tourist satisfaction and general attraction of the crater to tourists. Animal populations may decline in size over time, and/or be subject to increased disease. Animals may partly adapt by changing behaviour.	
Cumulative effects and their significance: Number of tourists may be reduced with a resultant loss in revenue	

Other comments: Stakeholders may blame the management for the problems around vehicle congestion if it is perceived that NCA does not construct and maintain roads of a sufficient quality. At times, many vehicles get stuck or obstructed in various places, and this increases the pressures on the accessible wildlife viewing locations. This increases the levels of disturbance on endangered species and habitats from tourist vehicles.

Conclusions VEC: The amount and type of disturbance from tourism vehicles is a threat to endangered species.

Recommendations VEC:
Research: The hypothesis is assumed to be valid. However, for designing management actions like zoning schemes and vehicle regulations it is recommended to carry out additional research to study specific issues related to vehicle disturbance:
1) Compile existing data and information on behaviour and distributions of key endangered species during different seasons with special emphasis on particularly vulnerable periods and locations.

2) Impacts to feeding, hunting, resting, and avoidance behaviour of endangered species.
3) Identify indicators of responses and consequences of tourism vehicles on endangered species for monitoring purposes.
4) Identify scientifically based critical vehicle (maximum) numbers with respect to acceptable levels of ecological impacts to endangered species
Monitoring: Monitoring of changes in densities and distributions of endangered species in relation to vehicle congestion.
Management:
1: Set standards for the maximum numbers of tourist vehicles accepted close to endangered species which must be communicated to tour drivers (standards may vary with season)
2: Establish a zoning system specifying the number of vehicles allowed in each area per day (standards may vary with season, cfr. Research no. 1).
3: Develop and implement a code of conduct for tour driver, including rules for how to approach animals, how to park and remain at a site, amount of time allowed to remain at a site and how to inform and communicate with the tourists, etc.
4: Develop an environmental education and awareness training program by NCAA for the tour drivers.
5: Consider expansion of purpose and activities of the tourist information centre at entrance in order to systematically informing visitors entering NCA about environmental issues and appropriate behaviour within the protected area. Information must be available in several languages (cfr. Proposal in Draft GMP for NCA 2006).

Impact Factor	Impact Hypothesis	Category	Period	Spatial	Temporal	Impact magnitude	Score	Impact level
Congestion of tourist vehicles	3-2 Increased congestion of tourist vehicles reduces hunting success per unit effort spent by carnivore	B	June-December	3	3	3	27	High negative

Consequences:	Remarks
Direct effects and their significance: Change in activities pattern of the carnivores	Change in animal behaviour i.e. feeding, mating, flight distance, they might be less shy
Indirect effects and their significance: Carnivore performance and population dynamics may be negatively affected.	Particular focus should be on cheetahs and lions
Cumulative effects and their significance: Change in population dynamics (population increase and/or decrease) of carnivores may affect tourism in the area.	

Other comments:

Conclusions VEC: Increased numbers of tourist vehicles at view spots will probably reduce the hunting success of carnivores.

Recommendations VEC:
Research: The hypothesis is assumed to be valid. However, for designing management actions like zoning schemes and vehicle regulations it is recommended to carry out additional research to study specific issues related to vehicle disturbance:
1) Compile existing data and information on behaviour and distributions of key carnivore species during different seasons with special emphasis on particularly vulnerable periods and locations (incl. comparisons with other areas like Serengeti, Maasai Mara).
2) Impacts to feeding, hunting, resting, and avoidance behaviour of carnivore species.
3) Identify indicators of responses and consequences of tourism vehicles on carnivore species for monitoring purposes.
4) Identify scientifically based critical vehicle (maximum) numbers with respect to acceptable levels of ecological impacts to carnivore species
Monitoring:
1) Monitoring of changes in densities and distributions of carnivore species in relation to vehicle congestion.
2) Long term monitoring of flight distances of herbivores in the Crater and outside the Crater.
Management: 1: Set standards for the maximum numbers of tourist vehicles accepted close to carnivore species which must be communicated to tour drivers (standards may vary with season)
2: Establish a zoning system specifying the number of vehicles allowed in each area per day (standards may vary with season, cfr. Research no. 1).
3: Develop and implement a code of conduct for tour driver, including rules for how to approach animals, how to park and remain at a site, amount of time allowed to remain at a site and how to inform and communicate with the tourists, etc.
4: Develop an environmental education and awareness training program by NCAA for the tour drivers.
5: Consider expansion of purpose and activities of the tourist information centre at entrance in order to systematically informing visitors entering NCA about environmental issues and appropriate behaviour within the pro-

tected area. Information must be available in several languages (cfr. Proposal in Draft GMP for NCA 2006).

Impact Factor	Impact Hypothesis	Cate-gory	Period	Spa-tial	Tem-poral	Impact magni-tude	Score	Impact level
Zoonotic diseases	3-3 Spread of zoonotic diseases can be influenced by congestion of tourist vehicles at the picnic sites and thus affect carnivores direct and indirect	C	January-December	3	3	3	27	High negative

Consequences:	Remarks
Direct effects and their significance: The number of local and international tourists may be reduced at NCA. Animal populations may decrease during certain periods. Human population can be severely affected by outbreaks.	Zoonotic diseases affects both human and wildlife health.
Indirect effects and their significance: Reduction of tourist flow in the NCA will reduce the revenue	
Cumulative effects and their significance: Support to local communities (Maasai) may be reduced. The dynamics of the ecosystem may be altered in unforeseeable ways, including possible multi-scale trophic effects. Genetic depression and in-breeding may occur in key species like cheetahs and lions. The image of NCA as an attractive tourism destination may suffer from disease outbreaks.	

Other comments:

Conclusions VEC: Outbreaks of zoonotic diseases are likely to have marked effects on key carnivore species like cheetah and lion and hence on the tourism industry..

Recommendations VEC:
Research:
This is a C hypothesis, and further research is needed to validate or invalidate the hypothesis.
1) Detailed study to establish spatial-temporal distribution and occurrence of zoonotic diseases at NCA should be carried out.
2) Study of tourism behaviour at picnic sites to determine degree of compliance with environmentally sound practices and regulations.

Given that the hypothesis is valid:
Monitoring:
1) Keep close track of outbreaks; i.e. locations, type, extent, mitigations
2) Long term monitoring of the use of tourism facilities
3) Monitoring of pollution and introduction of new species (biodiversity indexes) to the picnic sites environments (small scale habitats)

Management:
1) The common zoonotic diseases should be listed and tourists should be advised to check their health before entering the NCA.
2) NCA should provide the necessary information in the event of zoonotic diseases outbreaks to tourists before entering the Crater and other picnic sites.
3) Educating tour operators/drivers and tourists on proper use of tourist facilities provide at different places in the Crater. Improper behaviour should be penalised.
4) Improve lavatory and disposal systems to mitigate zoonotic diseases.

Impact Factor	Impact Hypothesis	Cate-gory	Period	Spa-tial	Tem-poral	Impact magni-tude	Score	Impact level
Conges-tion of tourist vehicles	3-4 Increased congestion of tourist vehicles at a kill may elevate the feeding time of the carnivores increasing inter and intra specific competition	C	June-December	3	3	3	27	High negative

Consequences:	Remarks
Direct effects and their significance: Carnivores may change their activity patterns.	Inter and intraspecific competition may affect population dynamics.
Indirect effects and their significance: Carnivore performance and population dynamics may be negatively affected. Tourists may fail to locate the hunting or feeding carnivores that may reduce the tourist	

satisfaction and general attraction of the crater to tourists.	
Cumulative effects and their significance: Number of tourists may be reduced and thus reduction in revenue	

Other comments:
Stakeholders may blame the management for insufficient handling of the vehicle congestion problems and resulting negative effects.

Conclusions VEC: Numbers of tourist vehicles at a kill should be limited and controlled.

Recommendations VEC:
This is a C hypothesis, and further research is needed to validate or invalidate the hypothesis:
Research:
Field observations to record animal activity patterns and behaviour at wildlife kills correlated with vehicle traffic volumes

Given that the hypothesis is valid:

Management:
1) Control of vehicle congestion at animal kill sites is highly recommended
2) Education of tour operators/drivers and tourists to avoid disturbing feeding carnivores and penalising improper human behaviour.

Impact Factor	Impact Hypo-thesis	Cate-gory	Period	Spa-tial	Tem-poral	Impact magni-tude	Score	Impact level
Tourism	3-5 Soil erosion will cause siltation of water bodies leading to altera-tion of water quality and quantity	C	January-December	3	3	3	27	High negative

Consequences:	Remarks
Direct effects and their significance: Poor quality and low quantity of water may affect nutritional status of wildlife hence reducing the population or set the local migration of wildlife.	No analysis of water quality issues was conducted as part of this project Assessment of impacts, conse-quences, and recommendations are based on the scoping results
Indirect effects and their significance: Poor habitat and low animal population may reduce the tourist satisfaction.	Alteration of water quality and quan-tity may affect health of wildlife.
Cumulative effects and their significance: The tourists may be dis-satisfied and thus not visiting the area. Hence, the revenue at NCA may be reduced.	

Other comments: This may affect community development activities supported by NCAA

Literature: Scoping report, Thomassen et al. 2005

Conclusions VEC: Traffic volumes that are likely to cause erosion should be controlled to protect sensitive habitats.

Recommendations VEC:
Research is needed to validate or invalidate this hypothesis
Research:
Impact of siltation in water bodies in the Crater
Monitoring:
Monitoring of water quality and quantity in time and space in the Crater
Management:
Protection of important catchments areas
NCAA might consider not allowing tourists to visit particularly sensitive locations (may be season dependent)

5 Synthesis of assessments

5.1 Potential impacts

Table 5 summarizes the potential impacts from tourist vehicle congestion in the Ngorongoro crater on VEC Maasai community, VEC tourism, and VEC Endangered species, Carnivores and Sensitive habitats.

Table 5. Potential impacts from tourist vehicle congestion in the Ngorongoro crater on VEC Maasai community, VEC tourism, and VEC Endangered species, Carnivores and Sensitive habitats.

Consequences	Triggered by
Direct effects and their significance. • Increased income and purchasing power • Loss of livestock and source of income • Increased income to Maasai community	VEC Maasai community
Indirect effects and their significance: • Reduction on reliance on government and donor agency funding as well as reliance on livestock as a core economic activity • Other development activities will be deprived of funds that otherwise is channelled to support the Maasai community. • Increased income will improve life standard, i.e. good education, health, houses, emigration. Reduced government and donors dependency. Reduced reliance on livestock as the core economic activity.	VEC Maasai community
Cumulative effects and their significance: • Improved livelihoods and reduced poverty • Increased poverty and economic marginalisation • Reduction of livestock number hence low livestock-wildlife competition**.**	VEC Maasai community
Direct effects and their significance: • Reduction in tourist visits to the Crater. • Reduction in revenue collected from tourist industry. • Poor policy will affect revenue, tourists, wildlife and environment**.** A coherent policy situation will facilitate tourism development and biodiversity conservation and sustainability considerations	VEC Tourism
Indirect effects and their significance: • Reduce revenue to NCA and national GDP. Administrative activities, environmental conservation measures and Maasai livelihoods will suffer from less funding generated by tourism. • The government will spend more funds for controlling the disease outbreak jeopardising other developmental activities. NCA will require additional government support to compensate for loss of tourism revenue • Reduced visitation will lead to reduction in revenue collection. A fragmented policy framework makes it complicated to assess carrying capacities, ecosystem services, as well as appropriate activities and use levels.	VEC Tourism
Cumulative effects and their significance: • Reduction in tourist number and subsequent reduction in revenue will lead government to increased subvention to Maasai community, jeopardising other development activities in other areas. Maasai community may demand the change in land use policy i.e. being allowed to cultivate both subsistence and cash crops. • It might be considered by foreign tourists that this is due to poor management and negligence of conservators and thus affect international tourism. The ecological balance may be disrupted if certain species are highly affected. • The policy framework is of great importance for the overall social and environmental conditions in the NCA. Some of the policies formulated may reflect prioritisation of certain values which lead to specific management strategies. This can affect Maasai livelihoods, NCA administrative activities and national GDP in different ways.	VEC Tourism
Direct effects and their significance • Endangered species may reduce their feeding and breeding activities due to disturbance from tourism vehicles. This might reduce the health and viability of the populations. • The number of local and international tourists may be reduced at NCA. Animal populations may decrease during certain periods. Human population can be severely affected	VEC Endangered species Carnivores and Sensitive habitats

by outbreaks. • Carnivores may change their activity patterns. • Poor quality and low quantity of water may affect nutritional status of wildlife hence reducing the population or set the local migration of wildlife.	
Indirect effects and their significance: • Carnivore performance and population dynamics may be negatively affected. • Tourists may fail to locate the endangered species that may reduce the tourist satisfaction and general attraction of the crater to tourists. Animal populations may decline in size over time, and/or be subject to increased disease. Animals may partly adapt by changing behaviour. • Reduction of tourist flow in the NCA will reduce the revenue • Poor habitat and low animal population may reduce the tourist satisfaction.	VEC Endangered species Carnivores and Sensitive habitats
Cumulative effects and their significance: • Number of tourists may be reduced with a resultant loss in revenue • Change in population dynamics (population increase and/or decrease) of carnivores may affect tourism in the area. • Support to local communities (Maasai) may be reduced. The dynamics of the ecosystem may be altered in unforeseeable ways, including possible multi-scale trophic effects. Genetic depression and in-breeding may occur in key species like cheetahs and lions. The image of NCA as an attractive tourism destination may suffer from disease outbreaks. • The tourists may be dissatisfied and thus not visiting the area. Hence, the revenue at NCA may be reduced.	VEC Endangered species Carnivores and Sensitive habitats

5.2 Recommendations

Table 6 summarizes all recommendations concerning VEC Maasai community, VEC tourism, and VEC Endangered species, Carnivores and Sensitive habitats due to tourist vehicle congestion in the Ngorongoro crater.

Table 6. Recommendations concerning VEC Maasai community, VEC tourism, and VEC Endangered species, Carnivores and Sensitive habitats due to tourist vehicle congestion in the Ngorongoro crater.

Recommendations ranked	Triggered by
Research 1) Conduct a GAP analysis to identify the deficiencies in the current policy situation as regards management of tourism in the NCA. 2) Assess the relevance of lesson learned in other multiple use and co-management settings of other protected areas for future management of NCA. 3) In depth study on the interaction between tourists, Maasai community and environment	VEC Maasai community
Monitoring 1) Extension services in the NCA should be provided to monitor the condition and health status of livestock as well as carrying capacity of NCA. 2) Long term monitoring program to determine the effects of invasive species	VEC Maasai community
Research: 1) Study to determine optimal sustainable use levels from a tourism visitor experience perspective (cfr. Research suggested for VEC Endangered Species, Carnivores and Sensitive Habitats) 2) Compile existing information from NCA and comparable areas on limits of acceptable change standards related to visitor experiences 3) Research program on the links between tourism industry, the natural environment and the Maasai livelihoods as input to development of management strategies and mitigating measures	VEC Tourism
Monitoring: 1) Long term monitoring of wildlife diseases in NCA. 2) Visitor satisfaction should be monitored every 5 years	VEC Tourism
Management actions: Management actions for tourism should be assessed in line with recommendations made for VEC Endangered species, Carnivores and Sensitive habitats 1) Establish a zoning system specifying the number of vehicles allowed in each area per day (standards may vary with season, cfr. Research no. 1 under VEC Endangered spe-	VEC Tourism

cies). 2) Set standards for the maximum numbers of tourist vehicles accepted close to endangered species (based on research) which must be communicated to tour drivers (standards may vary with season 3) Differentiated fee system in NCA i.e. high in the crater and low in other areas. 4) Consider expansion of purpose and activities of the tourist information centre at entrance in order to systematically informing visitors entering NCA about environmental issues and appropriate behaviour within the protected area. Information must be available in several languages (cfr. Proposal in Draft GMP for NCA 2006). 5) Develop an environmental education and awareness training program by NCAA for the tour drivers. 6) Develop and implement a code of conduct for tour driver, including rules for how to approach animals, how to park and remain at a site, amount of time allowed to remain at a site and how to inform and communicate with the tourists, etc. 7) Increase the training of NCAA staff on basic wildlife health and diseases 8) Strengthening veterinary services at NCAA 9) Strengthen the enforcement of rules for how picnic sites shall be used, i.e. avoid tourists walking outside permitted area. 10) Assess the need for rules governing how close tourists can approach wildlife	
Research: 1) Compile existing data and information on behaviour and distributions of key endangered and carnivore species during different seasons with special emphasis on particularly vulnerable periods and locations (incl. comparisons with other areas like Serengeti, Maasai Mara). 2) Identify scientifically based critical vehicle (maximum) numbers with respect to acceptable levels of ecological impacts to endangered species and carnivores. 3) Impacts to feeding, hunting, resting, and avoidance behaviour of endangered species and carnivores. 4) Identify indicators of responses and consequences of tourism vehicles on endangered species and carnivores for monitoring purposes. **Research to validate or invalidate hypotheses** 1) Detailed study to establish spatial-temporal distribution and occurrence of zoonotic diseases at NCA should be carried out. 2) Study of tourism behaviour at picnic sites to determine degree of compliance with environmentally sound practices and regulations 3) Field observations to record animal activity patterns and behaviour at wildlife kills correlated with vehicle traffic volumes 4) Impact of siltation in water bodies in the Crater	VEC Endangered species Carnivores and Sensitive habitats
Monitoring: 1) Monitoring of changes in densities and distributions of ungulates, endangered species and carnivores in relation to vehicle congestion 2) Long term monitoring of flight distances of herbivores in the Crater and outside the Crater. **Monitoring if hypotheses are valid** 4) Keep close track of outbreaks; i.e. locations, type, extent, mitigations 5) Long term monitoring of the use of tourism facilities 6) Monitoring of pollution and introduction of new species (biodiversity indexes) to the picnic sites environments (small scale habitats) 7) Monitoring of water quality and quantity in time and space in the Crater	VEC Endangered species Carnivores and Sensitive habitats
Management actions: 1) Establish a zoning system specifying the number of vehicles allowed in each area per day (standards may vary with season, cfr. research). 2) Set standards for the maximum numbers of tourist vehicles accepted close to endangered species and carnivores which must be communicated to tour drivers (standards may vary with season) 3) Consider expansion of purpose and activities of the tourist information centre at entrance in order to systematically informing visitors entering NCA about environmental issues and appropriate behaviour within the protected area. Information must be available in several languages (cfr. Proposal in Draft GMP for NCA 2006). 4) Develop and implement a code of conduct for tour driver, including rules for how to approach animals, how to park and remain at a site, amount of time allowed to remain at a site and how to inform and communicate with the tourists, etc. 5) Develop an environmental education and awareness training program by NCAA for the tour drivers.	VEC Endangered species Carnivores and Sensitive habitats

Management actions if hypotheses are valid (not ranked) • The common zoonotic diseases should be listed and tourists should be advised to check their health before entering the NCA. • NCA should provide the necessary information in the event of zoonotic diseases outbreaks to tourists before entering the Crater and other picnic sites. • Educating tour operators/drivers and tourists on proper use of tourist facilities provide at different places in the Crater. Improper behaviour should be penalised. • Control of vehicle congestion at animal kill sites is highly recommended • Education of tour operators/drivers and tourists to avoid disturbing feeding carnivores and penalising improper human behaviour • Protection of important catchments areas • NCAA might consider not allowing tourists to visit particularly sensitive locations (may be season dependent)	

5.3 Recommended monitoring and management actions

Table 7 summarizes recommended management actions and monitoring concerning VEC Maasai community, VEC tourism, and VEC Endangered species, Carnivores and Sensitive habitats due to tourist vehicle congestion in the Ngorongoro crater.

Table 7. Recommended management actions and monitoring concerning VEC Maasai community, VEC tourism, and VEC Endangered species, Carnivores and Sensitive habitats due to tourist vehicle congestion in the Ngorongoro crater.

Recommendations ranked
MANAGEMENT ACTIONS **Management actions for *VEC Tourism* and *VEC Endangered species Carnivores and Sensitive habitats*** 1) Establish a zoning system specifying the number of vehicles allowed in each area per day (standards may vary with season, cfr. Research no. 1 under VEC Endangered species) (Tourism/Endangered species Carnivores and Sensitive habitats). 2) Set standards for the maximum numbers of tourist vehicles accepted close to endangered species (based on research) which must be communicated to tour drivers (standards may vary with season) (Tourism/Endangered species Carnivores and Sensitive habitats) 3) Differentiated fee system in NCA i.e. high in the crater and low in other areas (Tourism). 4) Consider expansion of purpose and activities of the tourist information centre at entrance in order to systematically informing visitors entering NCA about environmental issues and appropriate behaviour within the protected area. Information must be available in several languages (cfr. Proposal in Draft GMP for NCA 2006) (Tourism). 5) Develop an environmental education and awareness training program by NCAA for the tour drivers. 6) Develop and implement a code of conduct for tour driver, including rules for how to approach animals, how to park and remain at a site, amount of time allowed to remain at a site and how to inform and communicate with the tourists, etc. (Tourism) 7) Increase the training of NCAA staff on basic wildlife health and diseases (Tourism) 8) Strengthening veterinary services at NCAA (Tourism) 9) Strengthen the enforcement of rules for how picnic sites shall be used, i.e. avoid tourists walking outside permitted area (Tourism). 10) Assess the need for rules governing how close tourists can approach wildlife (Tourism) **Management actions if hypotheses are valid (not ranked) (Endangered species Carnivores and Sensitive habitats)** • The common zoonotic diseases should be listed and tourists should be advised to check their health before entering the NCA. • NCA should provide the necessary information in the event of zoonotic diseases outbreaks to tourists before entering the Crater and other picnic sites. • Educating tour operators/drivers and tourists on proper use of tourist facilities provide at different places in the Crater. Improper behaviour should be penalised. • Control of vehicle congestion at animal kill sites is highly recommended • Education of tour operators/drivers and tourists to avoid disturbing feeding carnivores and penalising improper human behaviour

- Protection of important catchments areas
- NCAA might consider not allowing tourists to visit particularly sensitive locations (may be season dependent)

MONITORING

1) Monitoring of changes in densities and distributions of endangered species and carnivores in relation to vehicle congestion (Endangered species Carnivores and Sensitive habitats)
2) Long term monitoring of flight distances of herbivores in the Crater and outside the Crater (Endangered species Carnivores and Sensitive habitats)
3) Extension services in the NCA should be provided to monitor the condition and health status of livestock as well as carrying capacity of NCA (Maasai community).
4) Long term monitoring program to determine the effects of invasive species (Maasai community)
5) Long term monitoring of wildlife diseases in NCA (Tourism).
6) Visitor satisfaction should be monitored every 5 years (Tourism)

Monitoring if hypotheses are valid

7) Keep close track of outbreaks; i.e. locations, type, extent, mitigations (Endangered species Carnivores and Sensitive habitats)
8) Long term monitoring of the use of tourism facilities (campsites, toilets, picnic sites) (Endangered species Carnivores and Sensitive habitats)
9) Monitoring of pollution and introduction of new species (biodiversity indexes) to the picnic sites environments (small scale habitats) (Endangered species Carnivores and Sensitive habitats)
10) Monitoring of water quality and quantity in time and space in the Crater (Endangered species Carnivores and Sensitive habitats)

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7 Appendix

7.1 Technical reports from the studies conducted

7.1.1 The Maasai study (VEC 1 Maasai community)

Prepared by Hassan Nkya and Asanterabi Lowassa (TAWIRI)

I. Introduction

Tourism is a complex and one of the fastest growing industries with impressive earnings that involves local, national and international companies (Luvunga and Shikunda 2003). It provides employment and can boost agriculture, manufacturing, construction, small and medium sized enterprises, handcraft production and other services, which recognize the identity, culture and interest of indigenous people living around tourist circuits so that they benefit economically and socially. There is cash income from sells of handcrafts, grasses, firewood, food and drinks, traditional dances and folklores, making local people less vulnerable to disasters such as drought while at the same time ensuring food security by using money from tourism to buy food in poor agricultural years (Nabane 1995). Production of traditional handcrafts uncovers cultural skills thus empowering the local community and enhancing pride within the community. Tourism is therefore a route to micro economic growth, a form of sustainable use of wild resources and a way to enhance incentive for conservation and a component of rural development (Ashley 2000). However, there are also some negative effects arising from tourism, which can have unfavorable cultural, social, economic and environmental impacts to local people as well as the nation at large, such as immoral behaviour including drug abuse, prostitution, laziness and crime. In one study in Caribbean, 30% of tourists on the beaches were understandably known as drug users (Alleyne 1990). Drug taking is not only damaging in its own right but intravenous drug use is associated with transmission of the AIDS virus.

Ngorongoro Conservation Area (NCA) is renowned for its natural and historical features that make it a prime conservation site in the country and in the world at large. It is a World Heritage Site and a Biosphere Reserve, making it one of the key destinations for tourist globally, situated in part of Tanzania's Maasai land and Maasai have lived in this area since the 18th century (Lissu 2000). Apart from promoting tourism, one of its important mandates is to develop the well being of resident Maasai side by side with sustainable conservation of wildlife and other natural and archeological resources using money accrued from tourism and enabling them to establish tourism related enterprises. However, being one of the highly visited destinations by tourist in Tanzania, NCAA faces a great challenge in managing the vehicle congestion in the Ngorongoro Crater. The more vehicles that visit the Crater most likely the more money we get from tourists. Conversely, the more money we get from tourists the more bonuses the Maasai are likely to get for their livelihood. Nevertheless, it is not adequately known how vehicle congestion in the Ngorongoro Crater and therefore more revenue from tourism impact positively or negatively the Maasai communities directly or indirectly, who for years have paid heavily for the sake of conservation and tourism in terms of loss of land for grazing, rituals and loss of access to some important natural resources.

1.0 Methodology

Study sites
The study was conducted in the Ngorongoro Conservation Area in northern Tanzania, an area that is part of Tanzania Maasailand, and Maasai are known to have lived there since the 18th century. Five villages and three cultural bomas located close to the crater but along tourist circuit were chosen. These villages were Meshili, Oloirobi, Emisigio, Erkipus and Nainokanoka and cultural Bomas were Elerai, Seneto and Loongoku. In each village a sample of about 10-

12 people were chosen for discussion. Using a check list of questions, focus group discussion was used to collect data. Data collection was carried in two phases: focus group discussion was carried out in February 2006 and house hold survey where a sample of 150 respondents 30 from each village were interviewed in November 2006. The study intended to involve females and males from different age groups with exclusion of young children below the age of 18 years.

3.0 Results

3.1 Demographic variable of respondents interviewed during the study

This section represents results from a study conducted in five villages located along the Ngorongoro crater. Although we had intended to interview equal number of males and females, females were more encountered in Maasai Bomas than males except in one village Erkepus, most probably due to the fact that women are more responsible for family care particularly children while males move around. Out of 150 respondents interviewed using questionnaire from the five villages, 67 were males and 83 were females (Table 1). Majority of respondents aged between 25-55 years signifying that most of under aged were either in schools or were looking after cattle in the wild.

Table 1. Sex of respondents

Ward	Village	Male		Female		Total	
		No	%	No	%	No	%
Olbalbal	Meshili	12	40	18	60	30	100
Nainokanoka	Nainokanoka	13	43.3	17	56.7	30	100
	Erkipus	18	60	12	40	30	100
Oloirobi	Emisigio	13	43.3	17	56.7	30	100
	Oloirobi	11	36.7	19	63.3	30	100

Majority of respondents interviewed had no formal education as indicated in the table below in the five villages (Table 2). This was observed mostly to the fully grown class in many cases. However, during the interview, in the four villages located in Nainokanoka and Oloirobi wards, it was evidenced that education was accepted and there were two respondents who had reached higher learning institutions. Kids of all sexes were seen attending classes in primary schools, which were located in the five villages most probably due to emphasis on education facilitated by tourism funds channeled through various ways to build schools and sponsor outstanding students.

Table 2. Level of Education of respondents

Ward	Village	No School		<Primary		Primary		Secondary		College	
		No	%	No	%	No	%	No	%	No	%
Olbalbal	Meshili	25	83.3	0	0	3	10	1	3.3	1	3.3
Nainokanoka	Nainokanoka	16	53.3	0	0	13	43.3	1	3.3	0	0
	Erkipus	17	56.7	2	6.7	4	13.3	7	23.3	0	0
Oloirobi	Emisigio	23	76.7	1	3.3	2	6.7	4	13.3	0	0
	Iloirobi	18	60	2	6.7	3	10	6	20	1	3.3

There were a high percentage of people born in the five villages as evidenced in table 3. Majority of those who were not born in the five villages were females who had immigrated into these villages after marriage to follow their husbands.

Table 3. Places of Birth of Maasai living in the five villages

Ward	Village	Within the Village		Outside the Village		Total	
		No	%	No	%	No	%
Olbalbal	Meshili	18	60	12	40	30	100
Nainokanoka	Nainokanoka	25	83.3	5	16.7	30	100
	Erkipus	26	86.7	4	13.3	30	100
Oloirobi	Emissigio	26	86.7	4	13.3	30	100
	Oloirobi	27	90	3	10	30	100

3.2 Economic activities carried out by Maasai in Ngorongoro

Livestock keeping was found to be the most important economic activities carried out by Maasai in Ngorongoro. This was evidenced by 59.7% of the respondents in Erkipus, 53.3% in Oloirobi, 40% in Emisigio, 33.3% in Nainokanoka and lastly 30% in Meshili. Livestock keeping was followed by a combination of small-scale farming and livestock keeping particularly in Nainakanoka (63.3%), where they grow Irish potatoes and maize, and Emisigio (53.3%) where they grow maize.

3.3 Perception/Awareness of tourism by Maasai of Ngorongoro

It was evident that Maasai community currently understands benefits accrued directly or indirectly from Tourist industry. They admitted that in the past they did not see these benefits. During focus group discussion the key informants said that,'' *we have now realize the compensation to the opportunity cost of accepting the land for multiple land use including tourism. Now we have sense of ownership of wildlife alike as it is with our livestock*. Results from household survey indicated that between 86-100% of all the respondents interviewed in the five villages were well aware of the tourism industry in Ngorongoro (see table 4). In explaining this they mentioned that, *''We have now established tourist related enterprises such as cultural bomas, walking safaris, campsites and displays cultural beads and other artifacts. In some Cultural Bomas we are performing traditional dances to entertain tourists and accrue some revenue.*

The awareness was deemed good because it might provide an important input towards policy formulation, a process in which consensus on future direction for tourism development could to be directed. Maasai have been enabled and join hand in establishing tourist related enterprises such as cultural Bomas, walking safaris, campsites, sell of cultural artifacts, and performing traditional dances through which a substantial income and satisfaction is obtained.

Table 4. Awareness of Tourism industry by Ngorongoro Maasai

Ward	Village	Aware		Not aware		Total	
		No	%	No	%	No	%
Olbalbal	Meshili	30	100	0	0	30	100
Nainokanoka	Nainokanoka	29	96.7	1	3.3	30	100
	Erkipus	27	90	3	10	30	100
Oloirobi	Emisigio	29	96.7	1	3.3	30	100
	Oloirobi	26	86.7	4	13.3	30	100

3.4 Crater Value as perceived by Maasai of Ngorongoro

Maasai in NCAA realizes the importance of the Crater to their livelihood since time they arrived there. *''We have been benefiting to graze, salt leaking watering and tourism''*, he mentioned one old man in Oloirobi village during focus group discussion. In cause of time that privilege of Maasai to graze livestock in the Crater has progressively been declining and the Crater has remained for watering and salt leaking, and excludes grazing completely making original Crater benefit to Maasai decreased.

Results from questionnaires indicated that villages located closed to the crater such as Emisigio and Oloirobi were more affiliated with the crater than those far away. Meshili in Olbalbal followed these while least was Nainokanoka and Erkipus in the far east of the crater do not depend on the crater for watering their livestock. Instead they use river Munge, which is crossing along Erkipus and Nainokanoka villages (table 5).

Table 5. Percentage of Maasai who sees the Crater to have values to them

Ward	Village	Agree		Disagree		Total	
		No	%	No	%	No	%
Olbalbal	Meshili	26	86.7	4	13.3	30	100
Nainokanoka	Nainokanoka	24	80	6	20	30	100
	Erkipus	20	66.7	10	33.3	30	100
Oloirobi	Emisigio	28	93.7	2	6.7	30	100
	Oloirobi	28	93.7	2	6.7	30	100

It seems that the main value of the crater to Maasai community was originally pasture for their livestock, water and salt leaking as a package but later restricted to tourist attraction, salt leaking and water. However, these villages closer to the crater were having advantage of taking their cattle to the crater for water and salt leaking while cattle continue foraging as they move down and up the crater. One old respondent from Oloirobi indicated that NCAA is currently purchasing industrial salt for their livestock in order to decreasing the frequency of taking their livestock to the crater for salt leaking. However, the old man reiterated that they prefer natural salt found in the crater to industrial salt supplied by NCAA.

3.5 Tourist activities carried out by Maasai of Ngorongoro

Based on the study, findings within the studied villages in relation to tourist activities undertaken included participation in setting up campsites, where they get employment, sell firewood in Nainokanoka and Erkipus villages. In villages where cultural Bomas were in place, entrance fees were charged and sell of artifacts undertaken, traditional dances and photographing added into their source of income. In Emisigio walking safaris and climbing of mountain Makaroti created opportunities for employment of guides and porters. In Nainokanoka walking safaris to Empakai entailed renting donkeys and guides, and porters to assist on climbing mountain Ol donyo Lengai. In Oloirobi and Erkipus/Nainokanoka quite often young ladies were taken to ConsCorp and Sopa lodges respectively for evening traditional dances with a good return at the end of the day (see section 3.6).

3.6 Positive impacts of Tourism to Maasai

During focus group discussion we collected opinion from different villages based on the contribution of tourism to local community in NCAA. In villages like Emisigio and Oloirobi there were some people who do not known the contribution of tourism to their livelihood. However, in other villages like Nainokanoka and Meshili people were very positive and strongly agreed that tourism has brought positive impact to their lives. When we held discussion in Meshili village one of the informants was the chairman of pastoral council (Mr. Shaudo), he was seen to be very clearly on how the revenue collected from tourism by NCCA is distributed to community and he explained to us by saying that; ‘’*first and foremost there is an establishment of Pastoral Council through which a certain percentage of money accrued from tourism by NCAA is channeled and assist Maasai Community primarily in development activities. These activities include education, food security, income generating activities, health and veterinary services. Education for poor households is given emphasis but on average, 3 academically outstanding children are taken from each village and their education assured up to University level. Furthermore, classroom buildings and staff quarters are built for from money obtained from tourism through Pastoral Council. Maasai access food supply (maize and beans) easily and at comparatively cheaper prizes while at the sometime they get loans to establish small income generating projects through the same Council such as establishing women groups for making Maasai handcrafts*’’.

Furthermore chairman mentioned that, *Money from tourism also helps Maasai Community to improve their livestock keeping through ERETO – (joint venture between government of Tanzania and Denmark). This time NCAA acts on behalf of Tanzania Government. It is also understood that certain % of money from tourism reaches Maasai Community by NCAA channeling it to District Council. The money so channeled mostly is used in health care system such as setting up dispensaries and health centers as well as supplying medication, road improvements and veterinary services.*

This has also been reported in Erkipun villages where by one lady we found in cultural boma at Erkipun said that*, Tourism in NCAA has created employment opportunity at different levels for the Maasai Community and has diversified our living standards as well as alleviating poverty through subsidy to disadvantaged individuals*. One instance to elaborate this scenario was sighted as the outbreak of tick bone disease that drastically reduced the number of livestock in Maasai bomas. With the incorporation of tourism in their day to day activities i.e. setting up cultural bomas and selling artifacts, Maasai have been able to restock up their bomas with livestock using money accrued from tourism.

One aspect that is worthy mentioning here is that through tourism some Maasai boys and girls are educated to secondary education and sometimes to the University level. On one hand they are most likely exposed to the outside world, which in itself is learning. After education, they are most likely going to get some kind of employment. New thinking and new way of doing things will penetrate the Maasai old way of life. On the other hand, they will improve on their traditional way of doing things to enhance sustainability, i.e. sustainable conservation and livestocking and hence active participation in the tourism industry.

When we conducted household survey a large proportion of people interviewed in the five villages agreed that, tourism has had tangible benefits that have changed the livelihood of Maasai of Ngorongoro as summarized in table 6.

Table 6. Benefits of Tourism to Maasai

Ward	**Village**	**Agreed**		**Disagreed**		**Total**	
		No	**%**	**No**	**%**	**No**	**%**
Olbalbal	Meshili	24	80	6	20	30	100
Nainokanoka	Nainokanoka	27	90	3	10	30	100
	Erkipus	24	80	6	20	30	100
Olbalbal	Emisigio	24	80	6	20	30	100
	Oloirobi	22	73.3	8	26.7	30	100

On many occasions it was reported that tourists who happened to visit individual Bomas or primary schools traditionally left behind some donations. This was also eye witnessed by the researchers in one of Primary Schools (Makoromba) in Emisigio village whereby a pack of tourists was hosted by Emisigio village authority and the school management team negotiating on how to help their school. Also results have showed that, Maasai women sold firewood to campsites, they earned about Tshs 2,000/= per batch, while in walking safari local people were hired at between Tshs 5,000/= to Tshs 10,000/=. Donkeys in Nainokanoka were hired at Tshs 5,000/= and guide who accompanied donkeys are paid Tshs 10,000/=. Photographs were paid Tshs 500/= per shot and those ladies taken for evening performance were paid Tshs 2,500/= per head per evening. All these income were in addition to the Tshs 100,000/= paid as entry fees to cultural Bomas where Tshs 80,000/= goes to tour drivers and Tshs 20,000/= remains with cultural Bomas.

Table 7. Support from NCAA to Maasai in Ngorongoro

		Responses							
		Agreed		Disagree		I don't know		Total	
Village	**NCAA Support**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Meshili	Water	26	86.7	0	0	4	13.3	30	100
	Health	26	86.7	0	0	4	13.3	30	100
	Veterinary	25	83.3	1	3.3	4	13.3	30	100
	Education	25	83.3	0	0	5	16.7	30	100
	Roads	23	76.7	0	0	0	0	30	100
	School	21	70	1	3.3	8	26.7	30	100
	Food security	24	80	0	0	6	20	30	100
Nainokanoka	Water	29	96.7	1	3.3	0	0	30	100
	Health	30	100	0	0	0	0	30	100
	Veterinary	29	96.7	0	0	1	3.3	30	100
	Education	30	100	0	0	0	0	30	100
	Roads	29	96.7	1	3.3	1	3.3	30	100
	School	28	93.3	1	3.3	1	3.3	30	100
	Food security	30	100	0	0	0	0	30	100
Erkipus	Water	16	53.3	14	46.7	0	0	30	100
	Health	27	90	3	10	0	0	30	100
	Veterinary	28	93.3	2	6.7	0	0	30	100
	Education	29	96.7	1	3.3	0	0	30	100
	Roads	28	93.3	1	3.3	1	3.3	30	100
	School	28	93.3	2	6.7	0	0	30	100
	Food security	27	90	3	10	0	0	30	100
Emisigio	Water	24	80	4	13.3	2	6.7	30	100
	Health	27	90	0	0	3	10	30	100
	Veterinary	25	83.3	3	10	2	6.7	30	100
	Education	24	80	4	13.3	2	6.7	30	100
	Roads	26	86.7	2	6.7	2	6.7	30	100
	School	23	76.7	4	13.3	3	10	30	100
	Food security	24	80	4	13.3	3	6.7	30	100
Oloirobi	Water	27	90	0	0	3	10	30	100
	Health	19	63.3	9	30	2	6.7	30	100
	Veterinary	26	86.7	1	3.3	3	10	30	100
	Education	25	83.3	2	6.7	3	10	30	100
	Roads	26	86.7	1	3.3	3	10	30	100
	School	24	80	2	6.7	4	13.3	30	100
	Food security	25	83.3	2	6.7	3	10	30	100

Results from table 7 showed that a large percentage of Maasai in the five villages (70-100%) admitted that they get tangible benefits from tourism directly or indirectly through Ngorongoro Conservation Area Authority. This is in line with positive assurances by government as well as various Agreements that were put in place to oversee the interests of Maasai alongside with the sustainable conservation of the area.

3.7 Negative Impacts of Tourism to Maasai of Ngorongoro

The information on the negative impact of tourism to Maasai in NCA was initially gathered through focus group discussion by the use of checklist of question and the following results has been reported:

Cases of inter-racial sexual interactions have been reported in Nainokanoka village and therefore subjecting the Maasai Community to sexual transmitted diseases. Incidences of environmental pollution were cited by some members of Maasai Community in NCAA; particularly referring to plastic bags and foil papers that are known to be damaging to their livestock on one hand and wildlife on the other. Another damaging negative effect that tourism that been aired by Maasai to affect their Community in NCAA is competition for resources. The Maasai claim that of recent and due to increase in demand and most probably as a result of drought, there has been a high competition for water, pasture and campsites, and firewood between Maasai and the investors. This was sighted by Maasai of Erkipusini and Nainokanoka villages where conflicts of interest arouse between Sopa Lodge and residents from the two villages particularly in the peak of dry season.

Results from household survey indicated that exclusion of grazing livestock on the floor of the crater was seen as a big set back to Maasai livelihood. Incidences of inter racial interaction were lowly reported in all the five villages. Few incidences were reported in Erkipus, Meshili and Nainokanoka most probably because of walking safari activities that were more pronounced in these villages (table VII). However results from focus group discussion particularly in Nainokanoka and Erkipus indicated high conflicts of interest in resource use between the residents and Sopa Lodge and Campsites particularly in the peak of dry season. The main resources in question were pasture, water and firewood. Furthermore, disease transmission, which can easily be associated with inter racial association, was not seen as an issue except in Erkipus, a village very close to Sopa Lodge, with walking safaris and some Campsites and Meshili with a cultural Bomas located along major tourist route. This was reported by one guide in Nainokanoka during focus group discussion, he said that, "……".

Resource competition and environmental pollution were more pronounced in Erkipus followed by Nainokanoka and Emisigio (Table 8). On the pollution part, it was plastic bags and aluminium foils, which were a problem. Due to increase in demand as a result of Sopa Lodge development, and most probably due to drought periods, there has been a high competition for water, pasture and firewood between Maasai of Erkipus and tourist investors. These villages had campsite, walking safaris and mountain climbing tourist activities. Additionally there is Sopa Lodge, which is strategically located close to Erkipus village and therefore sharing resources with Erkipus.

Table 8. Negative Impact of Tourism to Maasai Community in Ngorongoro

Village	Impacts	Responses							
		Agree		Disagree		I don't know		Total	
		No	%	No	%	No	%	No	%
Meshili	Sexual interact-	2	6.7	28	93.3	0	0	30	100
	Pollution	0	0	29	96.7	1	3.3	30	100
	Diseases	0	0	29	96.7	1	3.3	30	100
	Resources	0	0	29	96.7	1	3.3	30	100
Nainoka-noka	Sex interact-	1	3.3	29	96.7	0	0	30	100
	Pollution	0	0	28	93.3	1	3.3	30	100
	Diseases	0	0	29	96.7	1	3.3	30	100
	Resources	1	3.3	28	93.3	1	3.3	30	100

Erkipus	Sex interact- Pollution Diseases Resources	3 5 3 5	10 16.7 10 16.7	27 25 27 25	90 83.3 90 83.3	0 0 0 0	0 0 0 0	30 30 30 30	100 100 100 100
Emisigio	Sex interact- Pollution Diseases Resources	0 1 0 1	0 3.3 0 3.3	30 29 30 29	100 96.7 100 96.7	0 0 0 0	0 0 0 0	30 30 30 30	100 100 100 100
Oloirobi	Sex interact- Pollution Diseases Resources	0 0 0 0	0 0 0 0	28 30 30 30	93.3 100 100 100	2 0 0 0	6.7 0 0 0	30 30 30 30	100 100 100 100

3.8 Mitigation measures to offset negative impact emanating from tourism.

- Collection of plastic bags and aluminum foils and destroy them was suggested as one way of curbing the problem.
- It was also suggested that tour drivers should adapt a habit of bringing firewood from far to avoid collecting them within the Maasai village. Some respondents suggested that Sopa Lodge should try to look for other alternative source of water to alleviate the problem of using the same source with the local Maasai in Erkipus.
- Environmental education to both tourists and tour guide so as ensure they do not haphazardly throw plastic bags was suggested by other respondents.
- Photographing along unspecified sites such as along tourist roads should be discouraged to minimize immoral acts.
- Maasai should be educated to understand risks involved with inter racial sexual contacts.

3.9 Attitudes towards Conservation of NCAA by Maasai

When the respondents were asked to explain their opinion on how they think Ngorongoro conservation area should be managed, more respondents were in favour of the area to continue being conserved (12-19%) as opposed to 1-11% who said that there was no need for conserving the area (Table 9). It is most probable that this positive attitude is due to enormous benefits that Maasai get from the tourist industry, which improves their livelihood and therefore commend for continuous conservation of the area. To ensure they continue benefiting from tourism money, Maasai are represented in the Board of Directors of NCAA through their Member of Parliament and in the Management through Pastoral Council, where important decisions on the conservation of the area and development of indigenous Maasai are made.

Table 9. General attitude towards existence of NCAA in Maasailand

Ward	**Village**	**Let it be conserved**		**Change to other uses**		**I don't know**		**Others**		**Total**	
		No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Olbalbal	Meshili	19	63.3	4	13.3	7	23.3	0	0	30	100
Nainokanoka	Nainokanoka	19	60	0	0	7	23.3	5	16.7	30	100
	Erkipus	6	20	0	0	7	23.3	17	56.7	30	100
Oloirobi	Emisigio	17	56.7	0	0	11	36.7	2	6.7	30	100
	Oloirobi	12	40	1	3.3	15	50	2	6.7	30	100

3.10 Conclusion

The rapid growth of international arrivals will with no doubt imply more tourist vehicles as well as more tourists and more income from the industry. Impact of tourism, both positive and negative, and directly and indirectly differs from one culture to the other depending on different livelihood needs and priorities.

First and foremost the Ngorongoro Maasai have agreed that tourism has had positive impact on their livelihood although it has been reported in other areas that with increased tourist activities many local people suffer reduced access to natural resources on which they depend (ODA 1999). In collaboration with the Management and Board of Ngorongoro they have able to establish the Pastoral Council through which a certain percentage of money accrued from tourism by NCAA is channeled through and assist Maasai Community primarily in development activities including roads, schools, health services, livestock development, setting up small enterprises, food security and educating outstanding students from primary school to University level. This is a big achievement in the Maasai community living in Ngorongoro Conservation Area.

However, for the tourism to continue to be beneficial to Maasai in the Ngorongoro, it has to be developed and managed sustainable. The destruction of tourism resources for short term profit usually denies the benefits to be gained from the access to and use of those resources in the future. Sustainable tourism must ensure that tourist activities and facilities are on a scale which matches the local community, and are sympathetic to and do not pollute the people and the environment. Although cultural pollution and immoral behavior have been cited as common especially in small island states (Briguglio *et al.* 1996), inter racial interaction, environmental pollution, resource competition, exclusion of local people from access to resources and disease transmission were the leading negative impacts of tourism as perceived by Maasai of Ngorongoro. This is why the question of tourist vehicles congestion in the crater, which brings in a lot of money that improve Maasai livelihood on one hand, is seen as a disaster and requires moderations on the other hand.

3.11 Recommendations

A study should be undertaken to ensure that with the continued influx of tourism and subsequent vehicle congestion in the crater harmonization between visitors' satisfaction, tourism development and the environment is compromised.

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7.1.2 The Tourism study (VEC 2 Tourism)

By Asanterabi Lowassa (TAWIRI)

1. Introduction

The Ngorongoro Conservation area (NCA) covers same 8,292 square kilometers. It is situated in Ngorongoro Districts Arusha region. The Ngorongoro conservation area was established in 1959 as a multiple land use area, designed to promote the conservation of wildlife and other natural reserves, interest of indigenous residents and tourism. This is a unique area in the whole of Africa.

Among the unique features of the NCA is the Ngorongoro crater, which covers an area of about 250 square kilometers. The Ngorongoro crater is internationally renowned for its rich wildlife and spectacular scenery. It supports high densities of wildlife through the year, which includes the population of black rhinoceros in the country: Also within NCA there two most important archaeological and Palaentological sites in the world; Olduvai Gorge and the Laetoli footprints at Ngarusi.

However, NCA is more than an area of biological and archaeological sites. It is inhabited by about 60,000 resident pastoralists (National Census. 2002), together with their livestock. It is because of this uniqueness that, UNESCO accorded the NCA the status of the world Heritage site and International Biosphere reserve. These features have attracted many visitors and the NCA has become one of the most visited tourist destinations in Tanzania and the world at large (GMP draft 2006-2016).

Based on information collected from tourism department in NCA the data recorded on visitor gate entries to the NCA has risen from 122,791 tourists in 1991 to 213,529 in 2000.According to the NCA General management plan (GMP 1996) reported that the Ngorongoro crater's capacity was approaching the saturation and that any further increase of tourists/visitors would result into destruction of wildlife and environment. This means that it is important to known the maximum permitted visitor use in this particular area.

In 2004 TAWIRI and NINA conducted an Environmental Impact Assessment workshop in Karatu and Ngorongoro crater was selected to be the study site under title: *Impact of tourist vehicles congestion in the crater*. Hereunder, results of the assessment are presented.

Methodology

This study was carried out in the Ngorongoro crater. About 400 tourists were interviewed using a questionnaire. The interview was conducted during lunchtime in the Ngoitokitoki spring. Before interviewing the tourists, researcher explained to tour guide and drivers the aim of the study and requested drivers/tour guide to ask tourists to fill the questionnaires (self-interview).

Limitation

Use of English language: Some tourists were not familiar with English language (the language used) during interview, i.e. like tourists came from Spain, Italy and France. Therefore, the researcher decided to exclude them from study.

2. Literature review

Tourists vehicles congestion. Tourism is one of the largest industries in today's world economy and is a great source of foreign exchange for many countries, whose major assets are their natural resources (Thullen 1996). Every year millions of tourists from around the world

tour our pristine nation's national parks. With the numbers of visitors and vehicles increasing rapidly, protecting the parks from environmental degradation has become more and more challenging, and the increase congestion and pollution are making new air quality control measures necessary. For instance in USA about three million people and nearly 900,000 vehicles visit Yellowstone national park. (www.ccities.does.gov/success). These vehicles emit about 20% to 33% of their fuel unburned, and produce high levels of hydrocarbons and carbon monoxide. But if not properly managed it can have adverse effect to the local people and environment.

Botswana is one of the best tourism areas in Africa, with high densities of many species of wildlife and attractive scenery (Modise 2001). With new diverse, well planned and managed tourism activities within and outside national parks and game reserves, Botswana can realize the potential of the tourism industry as the engine for economic growth.

The national tourist board of Sierra Leone has released that, there is a great impact of tourism activities on the environment and the rapid damage and uncontrolled tourism development can damage the environment. The Siera Leone government is very conscious of the importance of the conservation and protection of the environment in the development of the tourism resources in Sierra Leone. In this vein government adopted a policy of developing Sierra Leone as middle and Market destination and to ensure that the environment is maintained in the condition, which corresponds to the needs of the tourists, the local habitants and to national objective.

Tanzania is endowed with many resources, which benefit or, if exploited adequately and intelligently, can benefit the inhabitants of the country economically and socially (Tambila…). Wildlife –based tourism is or can be a very valuable industry in the country. Tourism based on wildlife is of two kinds, namely game viewing tourism and sport hunting tourism .It can contribute to the economy in two ways; by earning foreign exchange for the country and by providing very substantial employment. However, despite the positive sides of the tourism, negative effects from tourism to local people and environment are inevitable particularly with the increasing number of tourists.

Over the past decade, recorded visitors gate entries to the Ngorongoro Conservation Area have raised from 122,791 tourists in 1991 t0 213,529 in 2000 which represent an average annual rate of increase of about 7 per cent per year. The abundance and variety of wildlife, spectacular scenery and the viable and easily seen black rhinoceros that occurs naturally in the wild attract visitors in the Ngorongoro Crater (RPU of NCAA 2004).

During the preparation of the Ngorongoro Conservation Area General management plan (GMP 1996), they realized that the capacity of Ngorongoro Crater's was approaching the saturation and that any further increase of visitors would results to environmental destruction including wildlife in particular. Having noted this concept of ''Limits of Acceptable Use (LAU)'' came into consideration .LAU means the maximum permitted visitor use in a particular area. The concept differs significantly from the simple carrying capacity in that it takes into consideration not only the potential impact of the visitor use on the resource but also targets the desired visitor experience for the area. Maintaining the quality of the visitor experience is therefore often a more sensitive factor in determining visitor use levels than environmental degradation (RPU of NCAA 2004).

The two major issues that motivate planning for visitor and vehicles numbers in the Ngorongoro crater are the quality of product being sold and environmental degradation concerns. If the congestion of vehicles in the Ngorongoro crater is controlled, the tourists' enjoyment will increase thus making tourism business sustainable because the visitor's willingness to pay, which depends on satisfaction, will be maintained.

In order to maintain the satisfaction levels, the product, which includes wildlife viewing-on great spectacles, rare species of both animals and plants in their natural setting, has to be

conserved. Once animals are harassed, naturalness is disrupted by dozens of vehicles; jostling for a spectacular photo and once the visitors' satisfaction declines, wildlife tourism in the NCA will be in jeopardy. Based on this facts it is now important to determine how many vehicles should visit the crater at one particular time.

It is difficult to have a straight forward answer because vehicle congestion in the crater depends on the number, variety and distribution of animals, on which visitors wish to view and on the time they spend on most appealing animals and in particular the rhinos and big cats. In order to answer the above questions, the planning team proposed that a detailed research on impacts on animals, land and vegetation and at what point a visitor's satisfaction begin to suffer have to be initiated.

However, we should not wait for the research findings in order to act because by then it will be too late to reverse the situation of already deteriorated environment and the declined wildlife tourism industry. In this regard therefore, immediate six strategies, which may reduce consequences (are reached), are proposed. These are;

- Encouraging medium sized vehicles
- Cutting down the number of stay hours in the Crater through the introduction of shift system.
- Reviewing the pricing system.
- Diversification of attractions outside the crater.
- Revive the tracks, which were previously being used so as to increase the crater utilization.
- Training of tour drivers and guides.

(i) Introducing medium sized vehicles. In 1999, vehicles that entered the crater were 26840 carrying 148,805 visitors. On average each vehicle carried 5.5 visitors. The average number of visitors per vehicle entering the crater in 2000 decreased to 4.6 resulting into more vehicles entering the Crater, which were 29,953 (RPU of NCAA). According to NCAA experience, the planning team members' shows that on one hand most of the tourists prefer privacy and therefore they will not go for vehicles carrying many passengers. On the other hand there are tourists who come in-groups and this category in most cases use tracks and they are not bothered boarding vehicles with many visitors. Experience shows that the quality of touring starts to decline once passengers exceed 12 in one vehicle. From the 2000 visitor statistics, July was the month that recorded the highest number of visitors in the Crater.

Assuming that all the vehicles were in the Crater at one time and the GMP proposal of having only 50 vehicles was adhered to, each vehicle would have carried on average approximately 12 passengers per day, the maximum number of vehicle capacity that is proposed above. Since the plan does not want to deny rights of those who prefer privacy, a combination of both small and medium sized capacity vehicles are proposed. However, levies according to vehicle size and number of occupants are proposed. Whether a vehicle will carry more or les than five visitors a fixed fee for 5 people is proposed meaning that it is advantageous for an operator who will carry more than 5 passengers and the other way round to those who will carry less than this number.

In order to avoid monopoly of few operators, it is proposed that NCAA be in the forefront of introducing such medium sized vehicles for hire to tour operators who will fetch their clients at the rim and use such a service if needs arise. Otherwise NCAA should float a tender and invite those tour companies with experience in touring and who are interested in introducing medium sized vehicles of maximum capacity of 12 people.

(ii) Cut down the number of stay hours in the crater. In order to achieve the objective of having few vehicles in the crater at one time and at the same not denying others to visit the area the shift system is proposed. There should be at least two shifts one starting at 6.00 a.m.

to 12.30 p.m and another from 12.30 p.m to 12.30 p.m. to 6.30.p.m. If this system will work properly, it calls for more discipline to NCAA gatekeepers and tour drivers. On one hand the gatekeepers need to open the gates at exactly 6.00 in the morning and close at 6.30 in the evening. On the other hand, tour operators have to discipline the drivers who have the habit of rushing their visitors and leave the crater very late in the evening.

(iii) Booking system. The shift system calls for the booking procedure because all the vehicles booking intending to go down in to the Crater may wish to do so in one shift. If this happens, those visitors staying in hotels and camping sites within the NCA have to be given priority over those staying outside the Conservation Area. Otherwise a condition should be put in place that a visitor has to spend at least one day in the NCA in order to confirm the Crater visit and avoid embarrassment.

(iv) Review the Pricing system. It is known that the pressure point in the NCA is the Ngorongoro Crater. The value of the entering the NCA is driving in the Crater and not passing though the gate. The entrance fee at the gate should therefore be reviewed in such a manner that those passing through the gate and not intending to enter the Crater pay the premier. The fee for those entering the crater should be less but raising the Crater fee. This should be planned carefully such that the total revenue for the NCAA does not drop. For example, the current $ 25 entrance fee could continue being paid by those passing through and for those entering into the Crater be reduced to $20 but charge an extra $ 10 as Crater fee per head. The entrance rates in the NCA could be varied with low rates during low season and the vice verse in order to encourage off-season visitors. This scenario is already happening with some hotels whereby high-season accommodation rates differ from those of the off-season (RPU of NCAA).

(v) Diversification of attractions outside the Crater. Ngorongoro Conservation Area is endowed with enormous attractions that are not yet given due attention. These attractions range from montane forest, the Empakaai and Olmoti Craters, and the shifting sands at Olduvai, the Nasera Rock and the Olkarien George. These attractions if opened up will provide visitors with an opportunity to experience dense, relatively undisturbed habitats. While widening the scope for viewing base and offering special experience to visitors, the Crater is relieved from congestion pressure and the visitors get the chance of escaping from the car and scratch their legs by walking through such beautiful places.

It is proposed that the already started few hours hiking from hotels and days walking safaris in the NCA be strengthened and publicized. NCA is the home of the Maasai and some other indigenous people. Time could also be spent by tourists visiting the traditional/cultural bomas were they can learn about the Maasai fascinating way of life.

(vi) Revive previous tracks and introduce more designated sites. The current vehicle congestion in the Crater is localized because tracks are not spread evenly throughout the floor. In the past, there was a track going around the Crater rim. Other tracks that used to spread out visitors are now closed. Opening up of these previously available routes in and around the Crater will increase the number of kilometers, occupy more vehicles if a vehicle is to utilize 3 kilometres as recommended by the (GMP 1996) and thus reduce the problem of localized congestion. Furthermore, designated sites and view points where visitors can get out of their vehicles and spent sometime viewing attractions from one point for example at the hippo pool may also reduce vehicle congestion on the Crater floor. The tracks and designated sites on the Crater need to be maintained so that visitors can be attracted to them.

(vii) Training of tour guides and drivers. Tourists do not know the options available, their expectations my affect how the NCA is used, the impact of tourism and the level of congestion. For example if the visitors interested in seeing rhinos or lions, the capacity of the Crater would be limited in the number of vehicles, visibility resilience of the animals and visitors alike. Ob-

servations indicate that concentration of viewing in the Crater is on view animal species a situation that sets artificially high congestion of vehicles to certain animal.

Unawareness by visitors of not concentrating on other animal species, plants and other attractions in the Crater suggests that this narrow focus has more to do with prior conceptions and drivers and guides behaviors than the visitor apathy.

While tourism markets should aim at broadening the would be visitors on the many options and attractions available over the traditional interest on the "big five", drivers and guides should be trained in visitor interpretation. Training programmes for drivers and interpretative guides are a pre-requisite for any improvement in visitor use. Well-trained interpreters would diversify visitor interest and hence diversify visitor interest and attention.

3. Results

3.1 Socio-Economic and Demographic condition of tourists visited Ngorongoro September 2005.

A total of 400 respondents visited Ngorongoro Crater were interviewed in the picnic site in the Crater (Ngoitokitoki spring). Out of these males comprised of 183 which is equal to 45.8%, while female respondents were 210, which is equal to 52.5 % of all respondents (see table 3.1)

Table 3. 2 shows that majority of respondents interviewed from Ngorongoro Crater were aged between 26-55 years. This age category (26-55 years) comprised about 59% of the total respondents. Another category was respondents whose their age was above 56 years and they comprise about 31.8 % of all respondents interviewed in this study. Other category showed that 2.5% of these respondents did not like to indicate their age.

Regarding the level of education, the findings showed that majority of respondents have least university/college education. Out of 400 of respondents interviewed 307 people/tourists, which is equivalent to 76.8%, had completed university/college education, 73 people who is equivalent to 18.3% had completed secondary education. Other category showed that 13 people equivalent to 3.3% refused to indicate their education level (see table 3.3).

Based on the nationality of respondents visited Ngorongoro Crater during this survey, findings showed that majority was coming from United Kingdom, United state of America, Canada, Germany, and Netherlands. The rest were coming from countries like Australia, Belgium, Colombia, Costa Rica, Denmark, Finland, France, Hungary, India, Ireland, Italy, Norway, South Africa, Botswana, Portugal, Spain, Swaziland, Sweden and Tanzania.

Professionally, majority were employed in different fields. Some were engineers, financial managers, government employees, foresters, hair dressers, human resource, Insurance companies, journalists, land surveyors, lecturers, librarians, physicians, pharmacists, social workers, psychologists, research scientists, seller, surgeon, tax drivers, lawyers, teachers and some were retired.

3.2 How important the reasons influences tourists to visit Ngorongoro.

Based on the tourism survey conducted in Ngorongoro we have found that about 77.3% respondents interviewed during this survey had reported that wildlife in general is the very important reason for them to visit Ngorongoro. While about 11.3% respondents interviewed had mention wildlife as just important for their visit to Ngorongoro. However, 42% of respondents had reported that wildlife in general is an absolutely unimportant reason for them to visit Ngorongoro (see table 3. 2.1).

The study revealed that about 60.8% of respondents had shown large carnivores to be very important reason for them to visit Ngorongoro, while 27.5% of respondents had reported large carnivores to be important reason for them to visit Ngorongoro. On top of this, other tourists

(8.3%) had reported large carnivores to be absolutely unimportant reason for their visit to Ngorongoro Crater.

Results from table 3.2.1 showed that, about 56.8 % of respondents interviewed during this survey had mention birdlife as a very important reason for them to visit and 5.5% of these respondents reported birdlife to be absolutely unimportant reason for their visit to Ngorongoro.

Based on the research findings we had observed that some respondents interviewed had mentioned opportunity to see Crater landscape as their reason to visit Ngorongoro (see table 3.2.1). Other tourists who are close to 4.5% of respondents had refused that opportunity to see crater landscape is not their objective for visiting Ngorongoro.

The other reasons which has been reported by respondents include opportunity to see archeological sites, Maasai culture, to meet friends/family and opportunity to see UNESCO world heritage site as summarized in table 3.2.1.

3.3 Tourists opinions about Ngorongoro

Section 3.3 is presenting results on tourist's opinions about Ngorongoro. Study managed to gather information such as number of tourists who think Ngorongoro is unique, or Ngorongoro is among the best places in the world, or Ngorongoro is real managed, also information such as crowding of vehicles around wildlife site, facilities for tourists in the Crater and information on culture and archeological site were collected during this survey.

The other information collected includes number of vehicles in the Crater, size and standard of lodges, whether information to visitors is adequate, and if the level of tourists has no effect on the wildlife and their opinion about restricting tourism in parts of Ngorongoro. The results from this survey are summarized as in table 3.3.1.

3.3.1 Ngorongoro is unique and different from any place in the world

Results from table 3.3.1 showed that 53.5% of all respondents interviewed strongly agreed that Ngorongoro is unique and different from any other place in the world.

The other category, which is equivalent to 39.8 %, agreed on this opinion, while 3% of all respondents disagree and do not know whether Ngorongoro is unique and different from any other place in the world respectively.

3.3.2 Ngorongoro is the best place in the world

Based on the research findings majority of respondents interviewed, which is equivalent to 53.0 % agreed that Ngorongoro is the best place in the world. While the other category of respondents interviewed which is equivalent to 6 % of all respondents reported, they do not know whether Ngorongoro is the best place in the world or not (table 3.3.2). However, about 31.5% of all respondents interviewed reported that, they are strongly agreed with the opinion that Ngorongoro is the best in the world.

3.3.3 Ngorongoro is properly managed

Table 3.3.3 indicated that about 54.8% and 16.5% of all respondents interviewed agreed/strongly agreed respectively on the opinion that Ngorongoro is well managed. The other category which is equivalent to 22.9% of all respondents interviewed does not know if Ngorongoro is really managed.

3.3.4 Crowding of vehicles around wildlife site

Results from table 3.3.4 show that, about 41.8% of all respondents interviewed disagreed that crowding of vehicles around wildlife site disturbed their experience of wildlife in the Crater, while 35.3% of all respondents interviewed agreed that crowding of vehicles around the wildlife site disturbed their experience in the Crater.

3.3.5 Facilities for tourists in the Crater

Based on the research findings on tourist facilities in the Crater, about 46% of all respondents interviewed disagreed on the opinion that there are adequate facilities for tourists in the Crater while 22.8% of respondents interviewed agreed that facilities for tourist in the Crater is adequate (see table 3.3.5)

3.3.6 Overcrowding of good wildlife sites by tourists

Based on data from table 3.3.4 respondents reported that crowding of vehicles around wildlife site has no effect to their Crater experience. However, when the tourists were asked their opinion about the overcrowding of good wildlife sites by tourists, about 53.8 % agreed that most of good wildlife site are often overcrowded by tourists and 23.5% of all respondents interviewed disagreed on this opinion (see table 3.3.6).

3.3.7 Culture and archeological site

Majority of tourists (40.5%) agreed on the opinion that they visit Crater in order to see Maasai culture and archeological site while about 39.3 % of all respondents interviewed disagreed on this opinion (see table 3.3.7)

3.3.8 Number of vehicles in the Crater

Regarding the number of vehicles in the crater, table 3.3.8 showed that 38.5% of all respondents interviewed disagreed that the number of vehicles in the crater is high while 34.5% of respondents interviewed agreed that the number of vehicle in the Crater is high. Also 11.0% of all respondents interviewed do not know whether the number of vehicles in the Crater is large or low because they had never been to Ngorongoro before.

3.3.9 The size and standard of lodges

Regarding the size and standard of lodges 39.3% of respondents' interviewed agreed that the lodges were in the right size and shape. While 10 % of all respondents disagreed on the opinion that, the size and standard of lodges are in a right size and standard (see table 3.3.9)

However, 28.8 % of all respondents interviewed did not know if the size and standard of lodges were in the right size. This is based on the facts that this category of respondents did not sleep in this lodges they slept in the campsite or they were just on transit to other parks, i.e. Serengeti national park (see table 3.3.9).

3.3.10 Visitors information

About 56.3% of all respondents agreed that information to visitors was adequate while 15% of all respondents disagreed that the information to visitors is adequate (see table 3.3.10).

3.3.11 Tourism should be restricted in parts of Ngorongoro

Regarding the tourist's opinion on whether tourism should be restricted in parts of Ngorongoro about 50.5% of all respondents agreed and 16% disagreed on this opinion. While 14.3% of all respondents interviewed did not know whether it will be good or not to restrict tourists in other parts of Ngorongoro (see table 3.3.11).

3.3.12. Level of tourism has no effect on the wildlife

Table 3.3.12 show that 41.3% of all respondents interviewed disagreed that the level of tourism has no effect on the wildlife. This result indicated that tourists agreed on the opinion that tourism has effect on the wildlife. The other category of respondents interviewed, which is equivalent to 17.5%, agreed on the opinion that tourism has no effect on the wildlife (see table 3.3.12).

3.3.13.The benefits of tourism in the crater on Maasai culture

Results from table 3.3.13 indicate that 35.5% of all respondents interviewed do not know if Maasai culture benefits from the tourism in the Crater because all respondents did not assess whether Maasai culture benefits from tourism they just watch them while they are in the tourist

vehicles. The other category which is equivalent to 30.8% agreed that there are benefits of tourism in the Crater on Maasai culture while 24.5% of all respondents disagree that tourism in the Crater benefits Maasai culture.

3.3.14. The effect of tourism on the environment in the Ngorongoro Crater

Based on the research findings about 44.5% of all respondents interviewed agreed on the opinion that tourism has effect on the environment in the Ngorongoro Crater while 24.8% of all respondents interviewed disagree that tourism has effect on the environment in the Ngorongoro Crater (see table 3.3.14).

3.3.15 Development of tourism in other parts of Ngorongoro

About 43.3% of all respondents interviewed agreed that tourism should be developed in other parts of Ngorongoro outside the Crater (see table 3.3.15). While the other category of respondents, which is equivalent to 24%, did not know whether tourism should be developed in other parts of Ngorongoro.

4.0. The quality of the environment and visitor experience in Ngorongoro

4.1 Concentration of wildlife

Results from table 4.1 showed that about 41.8% and 47.8% of all respondents interviewed reported that they were satisfied/very satisfied on the concentration of wildlife in the Crater respectively.

4.2 Opportunity to see bird life

Among the tourists interviewed during this survey about 56.8% of all respondents reported that they were satisfied based on the fact that they had opportunity to see bird life in the Crater. The other category of respondents, which is equivalent to 32.3%, were very satisfied during their visit in the Crater and they got opportunity to see bird life (see table 4.2).

4.3 The amount of human impacts in the area.

Table 4.3 summarizes the results from the study conducted in the Crater in relation to amount of human impact in the area.

4.4 Tour guides

Study revealed that majority of respondents was very satisfied (58.8%) by the quality of tour guide. The other category of respondents, which is equivalent to 30.5% were also satisfied by tour guides quality (see table 4.4).

4.5 Quality of lodges

Regarding the quality of lodges majority of tourists were very satisfied. Based on the data from interview carried in the Crater about 34.5% of respondents were very satisfied with the quality of lodges. Table 4.5 also showed that about 26.3% of respondents interviewed reported that, they did not know about the quality of lodges in Ngorongoro because they slept in campsite.

4.6 Visitors information

Results from table 4.6 showed that about 29.5% of all respondents interviewed were satisfied with the quality of information provided by visitors' Information Center in Ngorongoro. However, other tourists who are equivalent to 38.5% did not know the quality of visitors' information, the reason might be that, they did not go to the visitors' information center, they were just relaying on the information provided by tour guides and drivers.

4.7 The cost of the trip

Majority of respondents interviewed about their opinion on the cost of the trip reported that they were satisfied (48.5%) with cost (see table 4.7).

4. 8 Accessibility to see wildlife in general
Results from table 4. 8 showed that about 45.5% and 44. 8% of all respondents interviewed were satisfied or very satisfied respectively due to opportunity to see wildlife n general.

4.9 Opportunity to see carnivores
Table 4.9 showed respondents who were interviewed about that three opinion on the opportunity to see carnivores in the Crater. About 48%of these respondents were satisfied while 35. 8% were very satisfied.

4.10 The scenic qualities of the landscape
Regarding the scenic qualities of the landscape about 56. 8% of all the respondents were very satisfied while the other category of respondents which is equivalent to 36. 8% were just satisfied with the scenic quality of the landscape in the Crater as summarized in table 4.10

4.11 Quality of Ngorongoro staff
Based on the results from table 4.11 majority of respondents who were equivalent to 39% did not met Ngorongoro staff so they did not now their quality. The other category of respondents, which is equivalent to 31.5% and 22.5%, were satisfied and very satisfied respectively.

4.12 The quality of campsites
Results from table 4.12 showed that majority of respondents did not now the quality of campsite. However, about 14% of respondents interviewed were satisfied by the quality of campsite and 5% were dissatisfied with the quality of the campsites.

5.0 Opinion of tourists whether they would visit Ngorongoro again if the following conditions changes

5.1 The wildlife populations are reduced by 50 per cent
Majority of respondents interviewed who are equivalent to 65.8% reported that, they would not visit Ngorongoro again if the wildlife populations will be reduced by 50% (see table 5.1). However, the other category of respondents, which was equivalent to 16.8%, did not know if they would visit Ngorongoro if the wildlife populations would be reduced by 50 %.

5.2 The number of tourists in the park/crater is doubled
Results from table 5.2 showed that about 72.5% of all respondents interviewed would not visit Ngorongoro if the number of tourists in the park is doubled. Also about 15.5% all respondents interviewed did not know whether they would visit Ngorongoro if the number of vehicles is double.

5.3 Introduction of a zoning system
Table 5.3 showed that 40.8% of all respondents interviewed agreed that they will visit Ngorongoro if a zoning system is introduced where you are only allowed to visit a certain sections of the Ngorongoro while 36.3% of all respondents disagreed on the use of zoning system.

5.4 Number of cars allowed in the crater each day is restricted
Based on the research findings it has been observed that, 76% of all respondents agreed to visit Ngorongoro if the number of cars allowed in the crater each day is restricted, while 12.3% of all respondents agree to visit Ngorongoro even if the number of cars allowed each day is not restricted (see table 5.4

5.5 Transport of tourists in the crater will be in the large vehicles operated by park staff.
Table 5.5 showed that majority of tourists who are equivalent to 56% of all respondents would not visit Ngorongoro if all the transport of tourists to Crater will be in the large vehicles operated by park staff. However, 20% of all respondents interviewed would visit and 19% of all respondents interviewed did not know whether they would visit Ngorongoro if all the transport of tourists in the crater would be in the large vehicles operated by park staff.

5.6 An environmental tax of USD 10 is added to the entrance fee

Regarding additional tax of USD 10 to the entrance fee about 54.3% of all respondents agreed to visit Ngorongoro Crater on additional of an environmental tax to the entrance fee. However, 22.8% of all respondents disagreed (see table 5.6).

5.7 The entrance fee is raised to USD 60 per day

Results from table 5.7 showed that about 41% of all respondents reported that, they will not visit Crater if the entrance fee rose to USD 60 per cent while 28%% reported that they will visit Crater even if the entrance fee would be raised to USD 60 per cent. The other category of respondents' equivalent to 27.3% does not now whether they would visit crater when the entrance fee would be raised by 60 per cent.

5. 8 Amount of roads in the park is doubled

About 55% of all respondents would not visit Crater when the amount of roads in the park would be doubled. However, the other category of respondents' equivalent to 22.3% would visit crater in regardless of the amount of roads that would be n the crater.

6. Discussion of the results

6.1 Vehicle congestion

Increasing park visitation and traffic congestion on the park roads can lead to environmental degradation together with visitor frustration. This problem has been observed in different National park and reserves in the world; every year millions of tourists from around the world tour our nation's pristine national parks. With the numbers of visitors and vehicles increasing rapidly, protecting the parks from environmental degradation has become more and more challenging, and the increase congestion and pollution are making new air quality control measures necessary (Thullen 1996). For example in USA about three million people and nearly 900,000 vehicles visit Yellowstone national park. (www.ccities.does.gov/success). These vehicles emit about 20% to 33% of their fuel unburned, and produce high levels of hydrocarbons and carbon monoxide.

In Africa particularly Sierra Leone, (The National Tourist Board of Sierra Leone) and Botswana has realized that, there is a great impact of tourism activities on the environment and the rapid damage an uncontrolled tourism development can damage the environment. The same problem has been reported at Grand Canyon National Park whereby, nearly 6000 vehicles compete for 2,400 parking spaces (www.nps.gov/transprortation/alt/index.htm). Vehicles congestion also causes air and noise pollution and threatens fragile natural and cultural resources including wildlife and visitors and other people.

The same results has been observed in Ngorongoro Crater (see table 3.3.8, table 3.3.12, table 3.3.14), whereby about 47.5% of respondent (34.5 % agreed + 13% strongly agreed) had reported that the number of vehicles in the Ngorongoro Crater is high. This could probably have been higher than 47.5% because there was other category of respondents (11.0%) who did not know whether the number of vehicles in the Crater is high or low because it was their first time to visit Ngorongoro Crater. As it has been reported by other researchers else where, that increasing vehicles and visitors congestion in the park can lead to visitor frustration, the same findings are reported in the Ngorongoro Crater. Results from table 5.2 showed that 72.5% of all respondents interviewed would not visit Ngorongoro Crater if the number of tourists in the park is double. Therefore, it is important for NCAA to put in place a proper way of controlling number of visitors entering the Crater so as to all quality tourism.

6.2 Diversification

In order to develop tourism industry that is viable it is important to diversify tourist activities. This can be archived by provision for alternatives activities such as night drives animal back safaris and accompanied by walking in the tourist attraction areas (Modise, 2001). This has been practiced in one of the game reserve called Moremi game reserve in Botswana, where by

the Mombo area has been designated as medium density zone. This zone allows 1 kilometres of road per 5 square kilometres of zone and I vehicle per 5 km of road. This area can be used for day and night game viewing, walking, wildlife filming, research and two lodges.

Result from table 3.3.14 showed that majority of visitors equivalent to 59.8% (agreed 44.5 + 15.3% strongly agreed) agreed that tourism has effect on the environment and its wildlife (see table 3.3.12 also). According to (RPU of NCAA 2001) and the GMP (1996) Ngorongoro Conservation Area is endowed with enormous attractions that are unexplored. These attractions range from montane forest, the Empakaai and Olmoti craters, and the shifting sands at Olduvai, the Nasera Rock, Olkarien George and Olmasini Mountain.

The same results have been observed in this study where by about 43.3% of visitors interviewed agreed on the opinion that tourism should be developed in other parts of Ngorongoro (table 3.3.15). These attractions if opened up will provide visitors with an opportunity to experience dense and relatively undisturbed habitats/destinations. While widening the scope for viewing base and offering special experience to visitors, the crater is relieved from congestion pressure and the visitors get the chance and opportunities of escaping from the car and scratch their legs by walking through such beautiful places.

6.3 Training of tour guides/drivers and Certification

Persuasive interventions such as interpretive programs and educational workshops between tour operators, guide/drivers and conservators/researchers are often effective in increasing knowledge, favourable attitudes and positive behavioral intentions about rules, resource ecology and resource protection in the park settings (Manfredo, 1992).Tour guides needs to do more than explaining the long truth about the to their clients. Once the tour guides/drivers are aquatinted with this knowledge they can help to diversify visitors to other tourist attraction areas in NCAA hence reduce the tourists' vehicles congestion in the Crater.

The other thing which is very important is certification of tour guide/drivers so that to ensure their familiarity with policies and regulations, interpretative skills and basic information to raise the standards of the tourism industry (Modise 200). Therefore all professional guides who accompany tourists into parks and reserves are requested to take and pass an examination in order to be issued with a licence. Results from this study showed that, about 29.5% of all respondents interviewed (Table 4.6) were satisfied with the quality of information provided by visitors' information center in Ngorongoro. However other tourists who are equivalent to 38.5% do not know the quality of visitor information, the reason might be that, they did not go to the visitors' information center, they were just relaying on the information provided by tour guides and drivers. However, it is important for NCAA and tour operators to have visitor interpretative centre, which will contain displays providing information on the area and its ecological components aimed at fostering a better understanding of the environment because some tourists might not be familiar with common languages.

6.4 Pricing System

Increase in existing parks and reserves fees and introduction of fees for new activities will limit the number of people visiting these areas. This has been observed in other different park and reserves. For example in Botswana they use differential pricing with three categories of fees for citizens, residents and non-residents (Modise 2001). In addition, tourists are required to make advance bookings in order to use facilities in the park and reserve.
It is known that the pressure point in the NCA is the Ngorongoro crater. The entrance fee at the gate should therefore be reviewed in such a manner that those passing through the gate and not intending to enter the crater pay the premier (RPU of NCAA 2001). Information from Daily news (January 23, 2006) reported that "*The NCAA has announced new entry charges for tourist vehicles descending into the famous crater, where by the former rates have now been hiked by 400 per cent. According to NCAA officials, the move is aimed at controlling the increasing rate of environmental degradation and pollution said to be caused by the influx of motor vehicles descending into the world's sixth largest caldera which is also home to thousands of wild*

animals" (Ngorongoro crater). Results from table 5.7 showed that about 41% of all respondents reported that, they will not visit crater if the entrance fee rose to USD 60 while 28%% reported that they will visit crater even if the entrance fee would be raised to USD 60 . The other category of respondents' equivalent to 27.3% does not now whether they would visit crater when the entrance fee would be raised by USD 60.

Regarding the additional environmental tax of USD 10 to the entrance fee about 54.3% of all respondents agreed to visit Ngorongoro crater despite of additional environmental tax to the entrance fee. However, 22.8% of all respondents disagree on the additional of this environmental tax to the entrance fee (see table 5.6). All these actions are aimed at diversifying tourist activities in NCAA and enhancing visitor experience and satisfaction.

6.5 Introduction medium size vehicles

Vehicle congestion has been observed to be among the major problem in managing of different parks and reserves. Park managers have tried to come up with alternative transport system in these pristine areas. In USA the National Park Service is exploring the use of buses and alternative transportation to accommodate more visitors in order to alleviate congestion, improve the visitor experience and protect park resources by reducing number of vehicles in the park. For example shuttle, buses, tram and trolleys.
(http://www.ccities.doe.gov/success/Yellowstone.html)

In 1999, vehicles that entered the Crater were 26840 and carrying 148,805 visitors. On average each vehicle carried 5.5 visitors. The average number of visitors per vehicle entering the Crater in 2000 decreased to 4.6 resulting into more vehicles entering the Crater, which were 29,953 (RPU of NCAA). According to NCAA experience, the planning team members' shows that on one hand most of the tourists prefer privacy and therefore they will not go for vehicles carrying many passengers.

The same results has been observed from this study where by majority of tourists who are equivalent to 56% of all respondents interviewed would not visit Ngorongoro if all the transport of tourists to crater will be in the large vehicles operated by park staff. However, 20% of all respondents interviewed would visit and 19% of all respondents interviewed did not know whether they would visit Ngorongoro Crater if all the transport of tourists in the crater would be in the large vehicles operated by park staff (Table 5.5).

This is based on the facts their tourists who come in-groups in most cases use tracks and they are not bothered boarding vehicles with many visitors. Experience shows that the quality of touring starts to decline once passengers exceed 12 in one vehicle. From the 2000 visitor statistics collected by NCAA, July was the month that recorded the highest number of visitors in crater (RPU of NCAA 2001).

6.6 Conclusions and Recommendations

Number of vehicles entering the Crater has increased tremendously since 1997 while the visitors' attraction has remained the same. This has lead to visitors' frustration and some visitors might not return to NCAA if the number of vehicles inside the crater would not be controlled. Mitigation factors should be taken to ensure visitors satisfaction while at the same time vehicles congestion and therefore quality tourism and sustainable conservation of the Crater

- Alternative transport system should be designed to fit into the natural setting of NCAA; this will improve the visitor experience and protecting park resources from degradation including wildlife and other natural resources.
- To establish other attraction areas for visitors, Empakai crater, Olmoti crater and others.
- Introduction of shifting and booking system
- Introduction of zooming system by install very powerfully binoculars at the view point so that the tourists will be able to see animals in the crater

- To educate tour guides and drivers about the rules, regulation and other park resource ecology so that to advice and diversify visitors to go to other places than Ngorongoro crater.
- Tourists numbers and satisfaction should be monitored and evaluated after every three years

Last but not least, possibility of introducing *''flying bridge''* other the Crater should be examined and if possible adopted to spread tourist to more avenues and enjoyment. In the long run this will have impact on social, economic and environment.

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Appendix to the tourism report: List of tables

Table 3.1. Information on the number of respondents by sex visited Ngorongoro

Sex	Number of respondents	Percentage of respondents
Females	210	52.5
Male	183	45.8
Missing values	7	1.8
Total	400	100

Source: Survey, 2005

Table 3. 2. Age composition of the respondents visited Ngorongoro

Age category/interval	Number of respondents	Percentage of respondents
1-25	27	6.8
26-55	236	59
Above 56	127	31.8
Missing values	10	2.5
Total	400	100

Source: Survey, 2005

Table 3. 3. Educational level of respondents visited Ngorongoro

Educational level	Number of respondents	Percentage of respondents
Primary education	7	1.8
Secondary education	73	18.3
University/College	307	76.8
Missing values	13	3.3
Total	400	100

Source: Survey, 2005

Table 3.2.1 Information on the reasons for tourists to visit Ngorongoro

Reasons	Responses					
	Absolutely unimportant	Unimportant	Important	Very important	Do not know	Missing values
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Wildlife in general	42(10.5%)	0	45(11.3%)	309(77.3%)	1(0.3%)	3(0.8%)
Large carnivores	33(8.3%)	4(1%)	110(27.5%)	243(60.5%)	3(0.8%)	7(1.8%)
Birdlife	22(5.5%)	61(15.3%)	227(56.8%)	80(20%)	4(1%)	6(1.5%)
Crater landscape	18(4.5%)	18(4.5%)	179(44.8%)	178(44.5%)	2(0.5%)	5(1.3%)
See a lot of wildlife in short time	26(6.5%)	41(10.3%)	148(37%)	179(44.8%)	1(0.3%)	5(0.3%)
Wilderness and ecosystem	26(6.5%)	22(5.5%)	165(41.3%)	167(41.8%)	5(1.3%)	15(3.8%)
Archeological site	26(6.5%)	151(37.8%)	120(30%)	63(15.8%)	25(6.3%)	15(3.8%)

Maasai culture	17(4.3%)	102(25.5%)	185(46.3%)	70(17.5%)	14(3.5%)	12(3%)
Get in touch with new people	52(13%)	101(25.3%)	143(35.8%)	78(19.5%)	9(2.3%)	17(4.3%0
Do something with friends or family	40(10%)	97(24.3%)	148(37%)	74(18.5%)	28(7%)	13(3.3%)
UNESCO	40(10%)	97(24.3%)	148(37.0%)	74(18.5%)	28(7%)	13(3.3%)

Source: Survey, 2005

Table 3.3.1.Information on the number of tourists who think Ngorongoro is unique and different from any other place in the world

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	0	0
Disagree	12	3
Agree	159	39.8
Strongly agree	214	53.5
Do not know	12	3
Total	**400**	**100**

Source: Survey, 2005

Table 3.3.2. Information on whether Ngorongoro is the best place in the world

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	3	0.8
Disagree	32	8.0
Agree	212	53.0
Strongly agree	126	31.5
Do not know	24	6.0
Missing values	3	0.8
Total	**400**	**100**

Source: Survey, 2005

Table 3.3.3.Information on whether Ngorongoro is really managed

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	2	0.5
Disagree	17	4.3
Agree	219	54.8
Strongly agree	66	16.5
Do not know	91	22.8
Missing values	5	1.3
Total	**400**	**100**

Source: Survey, 2005

Table 3.3.4. Information on crowding of vehicles around wildlife site

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	15	3.8
Disagree	167	41.8
Agree	141	35.3
Strongly agree	55	13.8
Do not know	13	3.3
Missing values	9	2.3
Total	**400**	**100**

Source: Survey, 2005

Table 3.3.5. Information on facilities for tourists in the crater

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	58	14.5
Disagree	184	46.0
Agree	91	22.8
Strongly agree	45	11.3
Do not know	18	4.5
Missing values	4	1.0
Total	**400**	**100**

Source: Survey, 2005

Table 3.3.6. Information on overcrowding of good wildlife sites by tourists

Level of response	Number of respondents	Percentage of respondents
Strongly disagree	4	1
Disagree	94	23.5
Agree	215	53.8
Strongly agree	63	15.8
Do not know	21	5.3
Missing values	3	0.8
Total	**400**	**100**

Source: Survey, 2005

Table 3.3.7.Information on culture and archeological

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	12	3.0
Disagree	157	39.3
Agree	162	40.5
Strongly agree	33	8.3
Do not know	30	7.5
Missing values	6	1.5
Total	**400**	**100**

Source: Survey, 2005

Table 3.3.8. Information on the number of vehicles in crater

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	6	1.5
Disagree	154	38.5
Agree	138	34.5
Strongly agree	52	13.0
Do not know	44	11.0
Missing values	6	1.5
Total	**400**	**100**

Source: Survey, 2005

Table 3.3.9.Inforation on the size and standard of lodges

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	8	2.0
Disagree	40	10.0
Agree	157	39.3
Strongly agree	76	19.0
Do not know	115	28.8
Missing values	4	1
Total	**400**	**100**

Source: Survey, 2005

Table 3.3.10 .Visitors information

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	8	2.0
Disagree	60	15.0
Agree	225	56.3
Strongly agree	33	8.3
Do not know	68	17.0
Missing values	6	1.5
Total	**400**	**100**

Table 3.3.11.Information on whether tourism should be restricted in parts of Ngorongoro

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	18	4.5
Disagree	64	16.0
Agree	202	50.5
Strongly agree	52	13.0
Do not know	57	14.3
Missing values	7	1.8
Total	**400**	**100**

Source: Survey, 2005

Table 3.12.Information on whether the level of tourist has no effect on the wildlife

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	69	17.3
Disagree	165	41.3
Agree	70	17.5
Strongly agree	12	3.0
Do not know	75	18.8
Missing values	9	2.3
Total	**400**	**100**

Source: Survey, 2005

Table 3.3.13.Information on the benefits of tourism in the crater on Maasai culture

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	13	3.3
Disagree	61	15.3
Agree	123	30.8
Strongly agree	50	12.5
Do not know	142	35.5
Missing values	11	2.8
Total	**400**	**100**

Source: Survey, 2005

Table 3.3.14.Information on the effect of tourism on the environment in the Ngorongoro

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	6	1.5
Disagree	99	24.8
Agree	178	44.5
Strongly agree	61	15.3
Do not know	51	12.8
Missing values	5	1.3
Total	**400**	**100**

Source: Survey, 2005

Table 3.3.15. Information on the development of tourism in other parts of Ngorongoro outside the crater

Level of response	**Number of respondents**	**Percentage of respondents**
Strongly disagree	7	1.8
Disagree	78	19.5
Agree	173	43.3
Strongly agree	38	9.5
Do not know	96	24.0
Missing values	8	2.0
Total	**400**	**100**

Source: Survey, 2005

Table 4.1.Information on the opinion of tourists about wildlife concentration

Level of response	**Number of respondents**	**Percentage of respondents**
Very dissatisfied	2	0.5
A little dissatisfied	31	7.8
Satisfied	167	41.8
Very satisfied	191	47.8
Do not know	4	1.0
Missing values	5	1.3
Total	**400**	**100**

Source: Survey, 2005

Table 4.2.Information on the opinion of tourists about opportunity to see bird life

Level of response	**Number of respondents**	**Percentage of respondents**
Very dissatisfied	2	0.5
A little dissatisfied	26	6.5
Satisfied	227	56.8
Very satisfied	129	32.3
Do not know	12	3.0
Missing values	4	1
Total	**400**	**100**

Source: Survey, 2005

Table 4.3. Information on the amount of human impacts in the area

Level of response	**Number of respondents**	**Percentage of respondents**
Very dissatisfied	6	1.5
A little dissatisfied	76	19
Satisfied	174	43.5
Very satisfied	37	9.3
Do not know	89	22.3
Missing values	18	4.5
Total	**400**	**100**

Source: Survey, 2005

Table 4.4 .Information on the opinion about tour guides quality

Level of response	**Number of respondents**	**Percentage of respondents**
Very dissatisfied	1	0.3
A little dissatisfied	15	3.8
Satisfied	122	30.5
Very satisfied	235	58.8
Do not know	19	4.8
Missing values	8	2.0
Total	**400**	**100**

Source: Survey, 2005

Table 4.5. Information on the opinion about lodge's quality

Level of response	**Number of respondents**	**Percentage of respondents**
Very dissatisfied	6	1.5
A little dissatisfied	27	6.8
Satisfied	114	28.5
Very satisfied	138	34.5
Do not know	105	26.3
Missing values	10	2.5
Total	**400**	**100**

Source: Survey, 2005

Table 4.6.Information on the opinion of tourist about visitor information quality

Level of response	**Number of respondents**	**Percentage of respondents**
Very dissatisfied	14	3.5
A little dissatisfied	62	15.5
Satisfied	118	29.5
Very satisfied	39	9.8
Do not know	154	38.5
Missing values	13	3.3
Total	**400**	**100**

Source: Survey, 2005

Table 4.7. Information on the opinion of tourists about the cost of the trip

Level of response	**Number of respondents**	**Percentage of respondents**
Very dissatisfied	19	4.8
A little dissatisfied	60	15.0
Satisfied	194	48.5
Very satisfied	33	8.3
Do not know	79	19.8
Missing values	15	3.8
Total	**400**	**100**

Source: Survey, 2005

Table 4. 8 Information on the opinion of tourists about accessibility to wildlife n general

Level of response	**Number of respondents**	**Percentage of respondents**
Very dissatisfied	4	1.0
A little dissatisfied	24	6.0
Satisfied	182	45.5
Very satisfied	179	44. 8
Do not know	2	0.5
Missing values	9	2.3
Total	**400**	**100**

Source: Survey, 2005

Table 4. 9 Information on the opinion of tourists about opportunity to see carnivores

Level of response	**Number of respondents**	**Percentage of respondents**
Very dissatisfied	1	0.3
A little dissatisfied	51	12. 8
Satisfied	192	48.0
Very satisfied	143	35. 8
Do not know	5	1.3
Missing values	8	2.0
Total	**400**	**100**

Source: Survey, 2005

Table 4.10. Information on the tourists' opinion on the scenic qualities of the landscape

Level of response	**Number of respondents**	**Percentage of respondents**
Very dissatisfied	1	0.3
A little dissatisfied	7	1. 8
Satisfied	147	36. 8
Very satisfied	227	56. 8
Do not know	10	2.5
Missing values	8	2.0
Total	**400**	**100**

Source: Survey, 2005

Table 4.11 information on the quality of Ngorongoro staff

Level of response	**Number of respondents**	**Percentage of respondents**
Very dissatisfied	4	1.0
A little dissatisfied	14	3.5
Satisfied	126	31.5
Very satisfied	90	22.5
Do not know	156	39.0
Missing values	10	2.5
Total	**400**	**100**

Source: Survey, 2005

Table 4.12 information on the quality of campsite

Level of response	**Number of respondents**	**Percentage of respondents**
Very dissatisfied	10	2.5
A little dissatisfied	20	5.0
Satisfied	56	14.0
Very satisfied	23	5. 8
Do not know	263	65. 8
Missing values	28	7.0
Total	**400**	**100**

Source: Survey, 2005

Table 5.1. Information on the opinion of tourists if wildlife population is reduced by 50 per cent

Response	**Number of respondents**	**Percentage of respondents**
Yes	57	14.3
No	263	65.8
Do not know	67	16.8
Missing values	13	3.3
Total	**400**	**100**

Source: Survey, 2005

Table 5.2.Information if the numbers of tourists in the park is double

Response	**Number of respondents**	**Percentage of respondents**
Yes	37	9.3
No	290	72.5
Do not know	62	15.5
Missing values	11	2.8
Total	**400**	**100**

Source: Survey, 2005

Table 5.3. Information on the opinion of tourist on the introduction of zoning system

Response	**Number of respondents**	**Percentage of respondents**
Yes	163	40.8
No	145	36.3
Do not know	75	18.8
Missing values	17	4.3
Total	**400**	**100**

Source: Survey, 2005

Table 5.4 Information on the number of respondents who would visit Ngorongoro if the number of cars allowed in the crater each day is restricted

Response	**Number of respondents**	**Percentage of respondents**
Yes	304	76
No	49	12.3
Do not know	34	8.5
Missing values	13	3.3
Total	**400**	**100**

Source: Survey, 2005

Table 5.5.Number of visitor who would visit Ngorongoro if all the transport of tourists in the crater will be in the large vehicles operated by park staff.

Response	**Number of respondents**	**Percentage of respondents**
Yes	80	20
No	224	56.0
Do not know	76	19
Missing values	20	5
Total	**400**	**100**

Source: Survey, 2005

Table 5.6: An environmental tax of USD 10 is added to the entrance fee

Response	**Number of respondents**	**Percentage of respondents**
Yes	217	54.3
No	91	22.8
Do not know	79	19.8
Missing values	13	3.3
Total	**400**	**100**

Source: Survey, 2005

Table 5.7.The number tourists who will visit crater if the entrance fee is raised to USD 60 per cent.

Response	**Number of respondents**	**Percentage of respondents**
Yes	112	28
No	164	41.0
Do not know	109	27.3
Missing values	15	3. 8
Total	**400**	**100**

Source: Survey, 2005

Table 5. 8 Number of tourists who would come to crater when amount of roads in the park is doubled

Response	**Number of respondents**	**Percentage of respondents**
Yes	89	22.3
No	220	55.0
Do not know	79	19. 8
Missing values	12	3.0
Total	**400**	**100**

Source: Survey, 2005

Reasons	Responses					
	Strongly disagree	**Disagree**	**Agree**	**Strongly agree**	**Do not know**	**Missing values**
	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)
NCA is unique and different from other place	0(0%)	12(3%)	159(39.8%)	214 (53.5%)	12(3%)	
NCA is the best place in the world	3(0.8%)	32 (0.8%)	212(53%)	126(31.5%)	24(6.0%)	3(0.8%)
NCA is really managed	2(0.5%)	17(4.3%)	219(54.8%)	66(16.5%)	91(22.8%)	5(1.3%)
Crowding of vehicles around wildlife site	15 (3.8%)	167(41.8%)	141 (35.3%)	55(13.8%)	13(3.3%)	9(2.3%)
Facilities for tourists in the crater	58(14.5%)	184(46.0%)	91(22.8%)	45(11.3%)	18(4.5%)	4(1.0%)
Overcrowding of good wildlife site by tourists	4(1%)	94(23.5%)	215(53.8%)	63(15.8%)	21(5.3%)	3(0.8%)
Culture and archeological site	12(3.0%)	157(39.3%)	162(40.5%)	33(8.3%)	30(7.5%)	6(1.5%)
Number of vehicles in the crater	6(1.5%)	154(38.5%)	138(34.5%)	52(13.0%)	44(11.0%)	6(1.5%)
Size and standard of lodges	8(2.0%)	40(10.0%)	157(39.3%)	76 (19.0%)	115(28.8%)	4(1%)
Visitors information	8(2.0%)	60(15.0%)	225(56.3%)	33(8.3%)	68(17.0%)	6(1.5%)
Tourism restricted in parts of NCA	18(4.5%)	64(16.0%)	202(50.5%)	52 (13.0%)	57(14.3%)	7(1.8%)
Level of tourists has no effect on the wildlife	69(17.3%)	165(41.3%)	70(17.5%)	12(3.0%)	75(18.8%)	9(2.3%)
Benefits of tourism on Maasai culture	13(3.3%)	61(15.3%)	123(30.8%)	50(12.5%)	142(35.5%)	11(2.8%)
Effects of tourism on the environment in NCA	6(1.5%)	99(24.8%)	178(44.5%)	61(15.3%)	51(12.8%)	5(1.3%)
Development of tourism in other parts outside the crater	7(1.8%)	78(19.5%)	173(9.5%)	38(9.5%)	96(24.0%)	8(2.0%)

7.1.3 The Ecological study (VEC Endangered species, VEC Carnivores and VEC Sensitive habitats)

By: Grayson G. Mwakalebe, Sigbjørn Stokke and Eivin Røskaft

Ecological aspects and analysis of Tourism Impacts on endangered species, Carnivores and Sensitive habitats.

INTRODUCTION

This survey is part of the collaborative programme in capacity building (2002 – 2006) between Tanzania Wildlife Research Institute (TAWIRI) and Norwegian Institute for Nature Research (NINA). The main purpose of this programme is to provide TAWIRI with basic knowledge and training in Environmental Impact Assessment (EIA). The purpose of this sub-study was to evaluate the effect of tourism traffic in the crater on endangered species, carnivores and sensitive habitats.

The natural ecosystem of the Ngorongoro conservation area (NCA) is highly appreciated, and rich in terms of large mammal species, carnivores and birds. A wealth of rare, endangered species and natural habitats positions the Crater floor among the most valuable Tanzania protected areas for nature conservation. The traditional local tourism and rich cultural heritage interact with the surrounding landscape creating a cultural landscape which has long been valued for its biophysical and cultural qualities.

As a result NCA has been subjected to a growing visitor pressure. Visitors have been estimated to increase from 96072 peoples in 1997 to 234452 peoples in 2005, whereas the number of vehicles increased from 20825 in 1997 to 48257 in 2005 (Fig.1 and Fig.2). Similarly, tourism infrastructure has been developing over the years and lodging possibilities have increased proportionally to the number of visitors. High levels of use across the Ngorongoro crater could lead to serious habitat degradation, disturbing animal populations or enfeebling their viability or basic biological functions, also high use levels could cause crowding problems thus reducing visitor enjoyment.

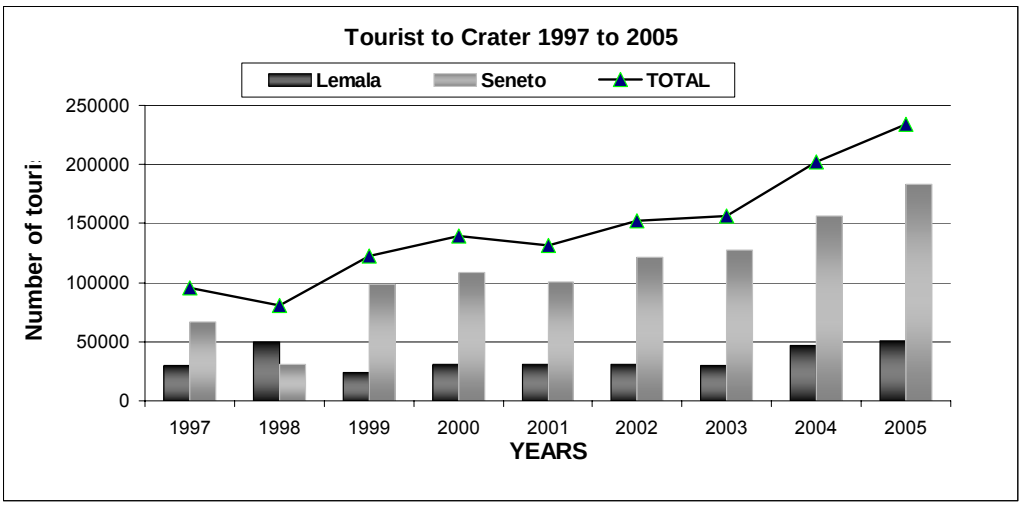

Figure 1. The graph shows the development of ten years increase in number of tourist into the Crater through Lemala and Seneto main gates. (Data source NCAA tourism office)

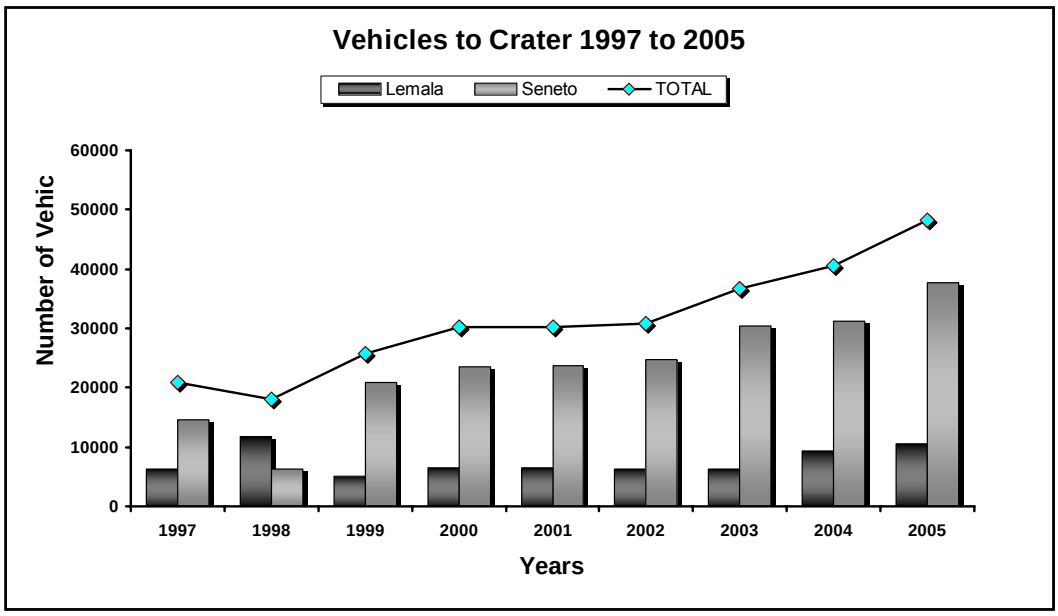

Figure 2. The graph shows the number of vehicles entered into the Crater through Lemala and Seneto main gates. (Data source NCAA tourism office)
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Here we address these questions by investigating the effect of tourist traffic on the animal populations inhabiting the crater floor. Our working hypotheses were the five hypotheses that were worked out at the Karatu workshop (2004):

IH 1.1: Congestion of tourist vehicles affects the activity pattern of endangered species

IH 1.2: Increased congestion of tourist vehicles reduces hunting success per unit effort spent by carnivores

IH 1.3: Congestion of tourist vehicles at a kill will elevate the feeding time of the carnivores increasing inter and intraspecific competition

IH 1.4: Soil erosion causes siltation into water bodies leading to alteration of water quality and quantity

IH 1.5: Spread of zoonotic diseases will be influenced by congestion of tourist vehicles at picnic sites and thus affect carnivores direct and indirect

Please note that hypothesis 1.4 could not be evaluated in a sound manner due to lack of resources and equipment.

METHODS AND ANALYSES

NCA covers an area of 8,280 km^2 and is situated about 190 km west of Arusha, Tanzania, and bordered by Serengeti National Park to the west, Loliondo Game Controlled Area to the north, and private and communal lands to the east and south. The Rift Valley passes to the east and south of NCA, and includes Lake Natron to northeast and Lakes Eyas and Manyara to the South. Nine volcanoes together form the topography of NCA, including those forming Olmoti and Empakaai Craters, and Ngorongoro Crater, which is one of the largest unbroken non-flooded calderas in the world (Randal, et al, 2001).

Water flows into the Crater from the north-east through the Lonyokie and Munge streams, from a series of springs high on the south wall and at the base of the eastern and western walls, and

from seasonal streams with small watersheds as the Leinai streams in the north. Drainage is internal and terminates in a large Soda lake, lake Makat, and several permanent and seasonal swamps which, with the exception of one to the north west of Kitati hill, are interconnected and affiliated with the lake (Herlocker et al, 1972).

To evaluate the hypotheses that were suggested by the Karatu workshop we basically applied two methodologies, distance sampling and direct observation of encounters between vehicles carrying tourists and animals on the crater floor.

Distance sampling:
The method is based on the fact that the probability of detecting an animal will decrease as the animal's distance from the survey line increases (Buckland et al. 2001). This trend is modelled as a probability distribution of detection in relation to the perpendicular distance from the transect line (Figure 3). One advantage of this approach is that variable sightability of a species in different habitat types is adjusted for and thus allowing a direct comparison of animal densities among the habitat types (Buckland et al. 2001).

Data were collected by 2 observers standing on the flatbed of a pickup, each covering a sector of 180^0 on their respective sides. When an object is spotted, the vehicle halts and the distance to the object is recorded with a Leica geovid range finder. Then the angle of the road, and angle of the straight line between the observer and the object were measured relative to true north with the rangefinder`s internal electronic compass (Figure 3).

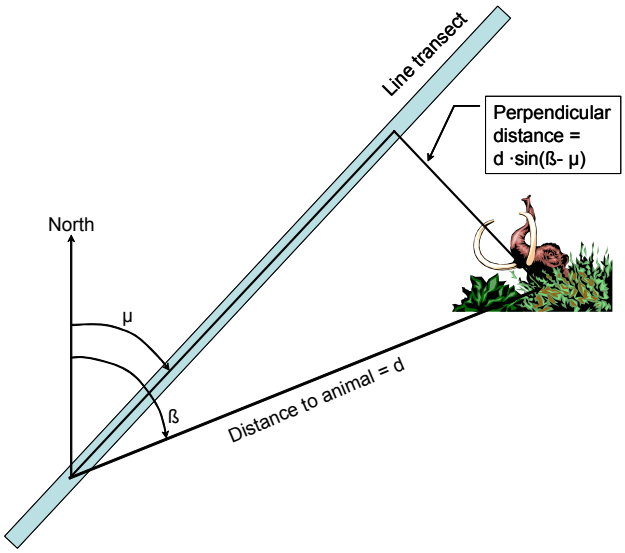

Figure 3. The basic measurements that were recorded during the survey relative to the transect line, the basic sampling unit. At the moment of detection the observers (at lower left) measured the distance (d) to the animal and angles (µ) and (β) relative to true north. The perpendicular distance can then be calculated as shown.

- We established 7 transects in the study area (list below and Figure 4). The transects were positioned along main tourist routes, but some were established in areas with less tourist activity (Figure 4: Ngoitoktok Spring, Munge River and Alayanai Hill trnsects). All transects were registered with GPS positions for starting and ending points to facilitate resampling throughout the survey period. During one survey, all transects were driven once and scanned for animals. Surveys were completed seven times between (and including) October 2005 and December 2006. In total, 154 km. were driven in transects during the survey period.

  - Lerai forest – Covers 6 transects in a stretch of 11 km
  - Oldonyo rumbe – Covers 3 transects in a stretch of 5 km
  - Engitat hill – Covers 6 transects in a stretch of 11 km

- Seneto road – Covers 3 transects in a stretch of 5 km
- Ngoitoktok Spring – Covers 1 transect in a stretch of 1 km
- Munge river – Covers 2 transects in a stretch of 3 km
- Alayanai hill – Covers 1 transect in a stretch of 1 km

-

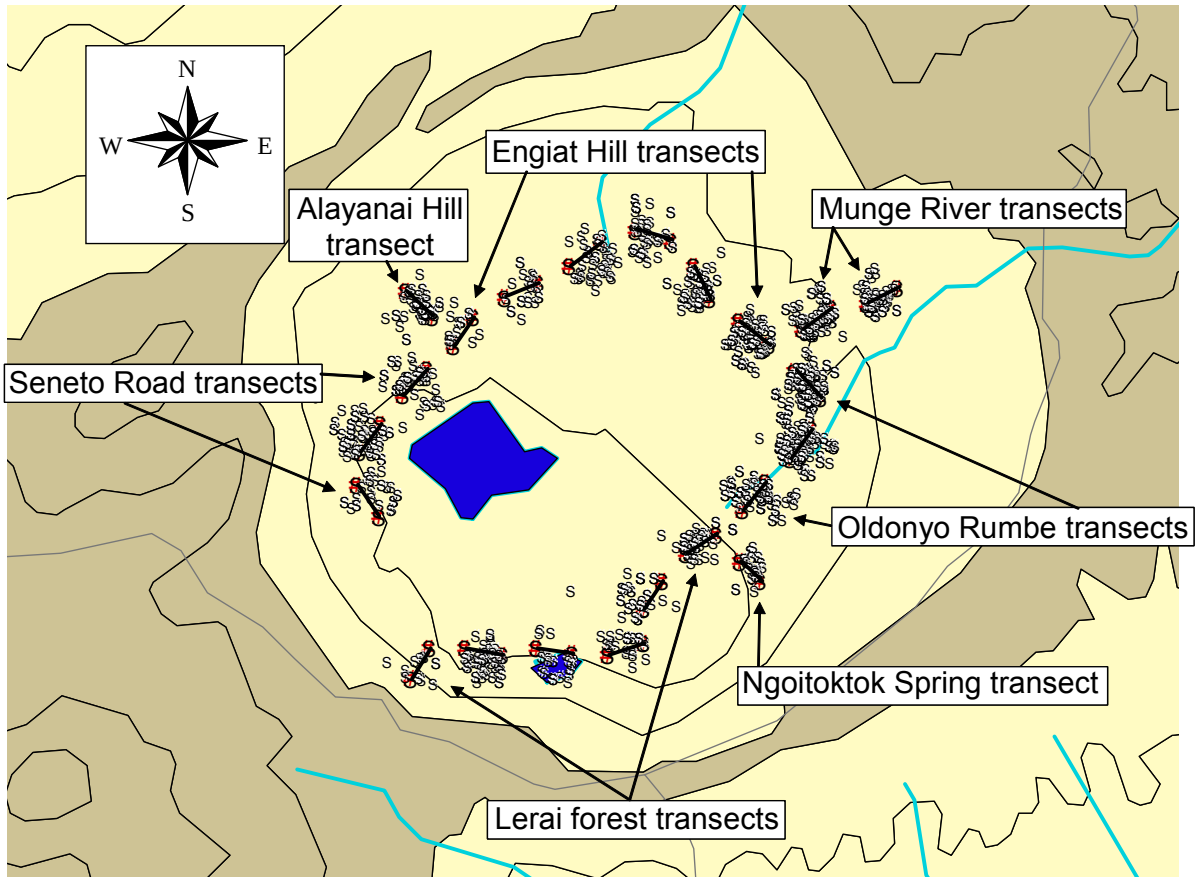

Figure 4. Overview of transects used in this study. The start and ending point of main transects are indicated by arrows in the figure. Each main transect is composed of subtransects (the sampling units) that are 1 km long and spaced by intervals of 1 km. The white circles represent all animal sightings.

Direct observation and influx of vehicles

To obtain more information about animal responses in relation to vehicle traffic and congregations of tourists close to carnivores, we applied direct observation from vehicles. As far as possible we tried not to interfere with the interaction between congregated vehicles and carnivores by observing from a distance using binoculars. A watch was used to measure time between events that was regarded to be important for the interaction, as for instance time spent by: tourists; carnivores before moving; carnivores before leaving etc. The position of the interaction was recorded by a GPS. In addition we recorded the following information: animal species, number and age structure; number of vehicles and tourists; and animal responses to visiting tourists. Data regarding the frequency of vehicles entering the crater was obtained from the NCAA tourism office.

- ***Distance Sampling analysis***

Data was entered and stored in excel during the survey period and transformed to a Visual FoxPro database before being analysed in Distance. Processing of the analysis followed the general guidelines of Buckland et al. (2001). We used DISTANCE (Ver. 3.5) for Distance sampling analyses. The main focus was to detect animal responses to tourist traffic and to estimate

densities of ungulates and carnivores to monitor population trends relative to earlier reported counts from the crater.

For all species data were pooled over the whole study period to increase the rigidity of the density estimates. However, for several species lack of data still was evident. In cases where data was insufficient to model density-estimates, a strip transect approach was applied to obtain a density estimate. In such cases, strip width was determined by selecting a perpendicular distance resembling a detection probability of at least 80%. Truncation of data followed the recommendations of Buckland et al. (2001). The following key estimators were specified as models: Uniform, half-normal, hazard-rate or negative exponential adjusted with Cosine, Simple polynomial or Hermite polynomial as expansion series. The best model was selected by examining AIC-values. Abundances (population sizes) for species on the crater floor were estimated assuming that the floor covers some 250 km^2.

RESULTS

During the study period a total of 7770 tourists entered the crater using 1722 vehicles (figure 5: thick and thin black lines). There was a pronounced peak during February in 2006. The number of vehicles exhibits the same trend, though the February peak is not so obvious for vehicles. The number of vehicles and boarded tourists spotted by the observers does not closely track the main influx trend (figure 5: thick and thin gray lines). The observers did not discern the large influx of February and they missed all in October 2005. In total the observers encountered 955 tourists and 195 vehicles during the study period.

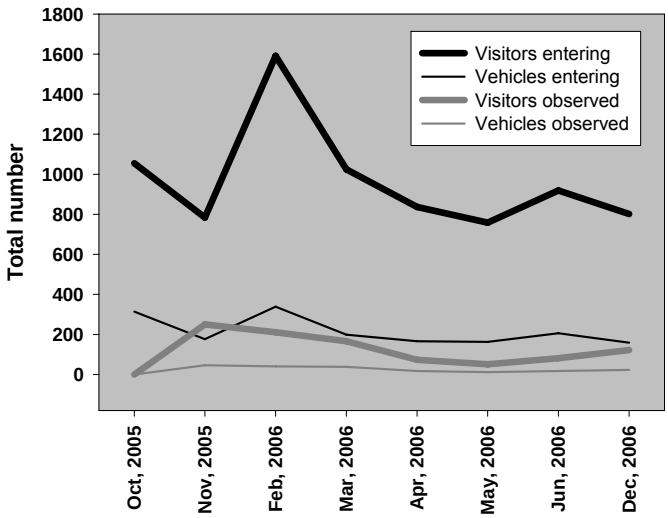

Figure 5. The graph shows the number of tourists (thick black line) and vehicles (thin black line) entered into the crater through Seneto and Lemala gates during the survey period. Additionally the graph shows the number of tourists (thick grey line) and vehicles (thin grey line) encountered by the observers in the crater during the survey period**.**

Animal densities and land use in relation to the road system in the crater

In total 25 different species were observed during the survey, whereof 3 species are domesticated (sheep, donkey and cow) (table 1, Figure 4). Four species were seen only once (topi, serval, vervet monkey and baboon). Reliable density estimates relies on sample sizes of at least 30 or preferentially 60 cases or more (Buckland et al. 2001). This means that sturdy estimates can only be achieved for 7 species (table 1; wildebeest, zebra, thomson's gazelle, buffalo, grant's gazelle, ostrich and warthog).

Table 1. The table shows all species observed during the survey. Encounters are the number of times a species was observed (solitary individual or cluster of animals). The total number of individuals seen and average cluster size for each observed species is also exhibited.
For the remaining species the estimates are uncertain or very uncertain for those with fewest observations. Cheetah and black rhino were observed so infrequent that an estimate is impossible. For cheetah we have only 5 observations. Most cheetah were detected more than 100 meter from the road (233, 253, 112, 45, 124). Four of these observations represent solitary individuals seen in Engitat hill, whereas one observation represents 2 individuals seen at Seneto road. We do not know if some of these animals represent resightings of the same individuals, but all in all this suggests that the population is quite small.

Common name	Scientific name	Number of encounters	Total	Average clustersize
Topi	*Damaliscus lunatus*	1	1	1
Serval	*Felis serval*	1	1	1
Vervet monkey	*Cercopithecus pygerythrus*	1	3	3
Baboon	*Papio cynocephalus anubis*	1	30	30
Sheep	*Ovis aries*	2	68	34
Donkey	*Equus asinus*	2	18	9
Silver backed jackal	*Canis mesomelas*	4	5	1
Black rhino	*Diceros bicornis*	4	16	2
Cheetah	*Acinonyx jubatus*	5	6	1
Golden jackal	*Canis aureus*	7	8	1
Lion	*Panthera leo*	8	33	4
Eland	*Tragelaphus oryx*	8	43	5
Cow	*Bos taurus*	11	732	67
Guinea fowl	*Numida meleagris*	20	63	3
Hippopotamus	*Hippopotamus amphibius*	21	230	11
Hyaena	*Crocuta crocuta*	21	47	2
Hartebeest	*Alcelaphus buselaphus*	32	191	6
Elephant	*Loxodonta africana*	35	219	6
Warthog	*Phacochoerus aethiopicus*	76	192	3
Ostrich	*Struthio camelus*	78	292	4
Grant gazelle	*Gazella granti*	103	1093	11
Buffalo	*Syncerus caffer*	117	2503	21
Thomson gazelle	*Gazella thomsonii*	130	1580	12
Zebra	*Equus burchelli*	283	6426	23
Wildebeest	*Connochaetes taurinus*	423	8481	20

Black rhinos were seen on three occasions, twice in Lerai forest (1 adult and 2 adults) and once outside transects (1 adult). It is impossible to estimate any density, but the population is apparently low.

Lions were observed on average at a perpendicular distance of 240 meters from the road and never closer than 40 meters, indicating that they prefer to keep a distance from the road. But lack of a sufficient amount of data makes this suggestion very uncertain.

Table 2. Estimates of density and abundance (population size) for important species on the Ngorongoro crater floor. Densities are given as individuals per square km. Lower and upper confidence limits (95%) are indicated as LCL and UCL. The model column shows the applied key modelling function plus serial expansion type if Distance was used as an estimator or it shows if a strip transect approach was used. For hyena and hartebeest additional strip transect calculations were conducted but they turned out to be quite close to the modelled estimate, so they are not indicated in the table.

Common name	Density estimate in ind/km^2 (LCL – UCL)	Abundancy estimate	Model	Comments
Lion	0.2	58	Strip transect approach	Poor estimate
Hyaena	0.6 (0.2 – 1.5)	150	Negative exponential + cosine	Poor estimate
Hartebeest	0.7 (0.3 – 1.4)	175	Hazard-rate + cosine	Poor estimate
Elephant	0.3	65	Strip transect approach	Poor estimate
Warthog	1.2 (0.8 – 1.8)	300	Half-normal + cosine	Reliable estimate
Ostrich	1.2 (0.8 – 2.0)	300	Uniform + cosine	Reliable estimate
Grant gazelle	5.7 (3.6 – 9.1)	1425	Hazard-rate + cosine	Reliable estimate
Buffalo	7.6 (3.7 – 15.4)	1900	Negative exponential + cosine	Reliable estimate
Thomson gazelle	12.0 (6.8 – 21.0)	3000	Half-normal + cosine	Reliable estimate
Zebra	37.2 (24.7 – 56.0)	9300	Uniform + cosine	Reliable estimate
Wildebeest	50.6 (26.8 – 95.4)	12650	Uniform + cosine	Reliable estimate

Table 2 exhibits density and abundancy estimates for 11 species occupying the crater floor. Abundancy per species (total number in the crater) can be estimated as we know the area of the crater bottom. We have good estimates for seven species (table 2) and of these wildebeest is the most common species in the crater with 12650 members. Zebra is closest to this number at 9300 individuals. Then there is a gap down to thomson, buffalo and grant which occurs at some thousand individuals per species. Ostrich and warthog were estimated to count 300 individuals each. For the remaining species the estimates are poor due to few encounters and estimated numbers are therefore uncertain.

In general the animals exhibited a tendency to avoid staying close to the roads in the crater (species pooled data, figure 6). The probability of detecting an animal more than 100 meter from the road was higher than the probability of detecting an animal on or closer to the road. Animals were most likely to be detected about 150 from the road. There is also a pronounced second peak around 500 meters from the road, indicating that some animals prefer keeping a firm distance from the roads.

Elephants, on the other hand, are large animals with almost no enemies when un-hunted and in open habitat types they can be observed far out from the road (Figure 7). It is thus difficult to build a reliable detection curve exhibiting a typical shoulder as elephants were observed far out just as frequently as they were observed close to the road (Figure 7). Elephants therefore apparently do not show any typical avoidance response to roads and traffic in the crater.

When the detection-probability is analysed per month, the pattern is somewhat modified, but the main trend is still the same – animals tend to keep a distance from the road (pooled species data, figure 8). The highest peak, indicating the distance most animals kept away from the roadside, never was adjacent to the road. Thus, suggesting that the pattern was more or less consistent throughout the study period. There was no obvious synergy between the distance most animals kept away from the road and the number of tourists and vehicles seen by the observers or corresponding numbers registered at the entrance gates. So apparently there is no direct link between tourist influx frequency and shunning behaviour exhibited by the animals in relation to the roads.

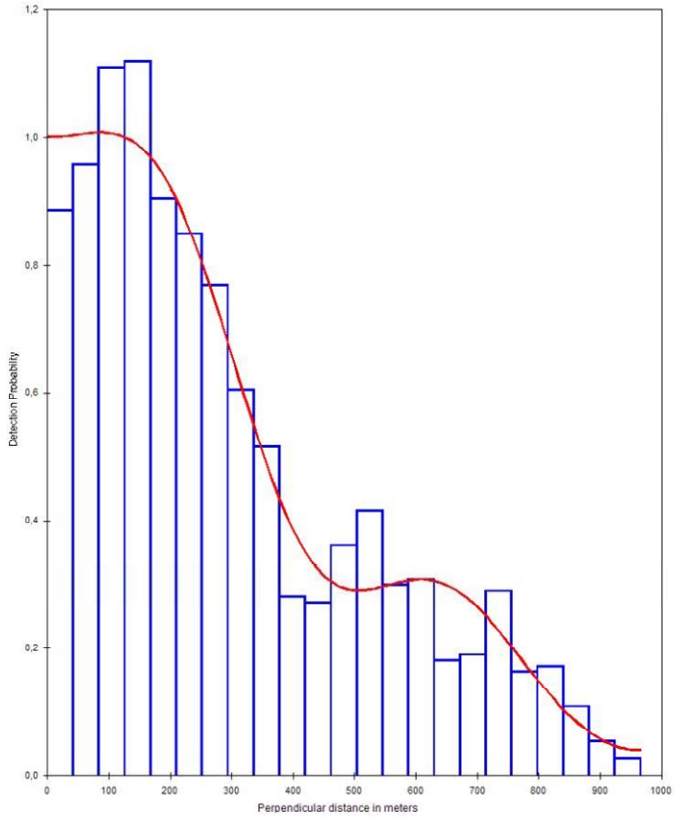

Figure 6. The observed probability (vertical bars) for detecting an animal in relation to its perpendicular distance from the road. The graph is based on pooled data for the most common species detected during the survey. Animals are most commonly detected between 100 and 200 meters from the road. The red curve represents the modelled detection probability for the observations assuming no road avoidance.

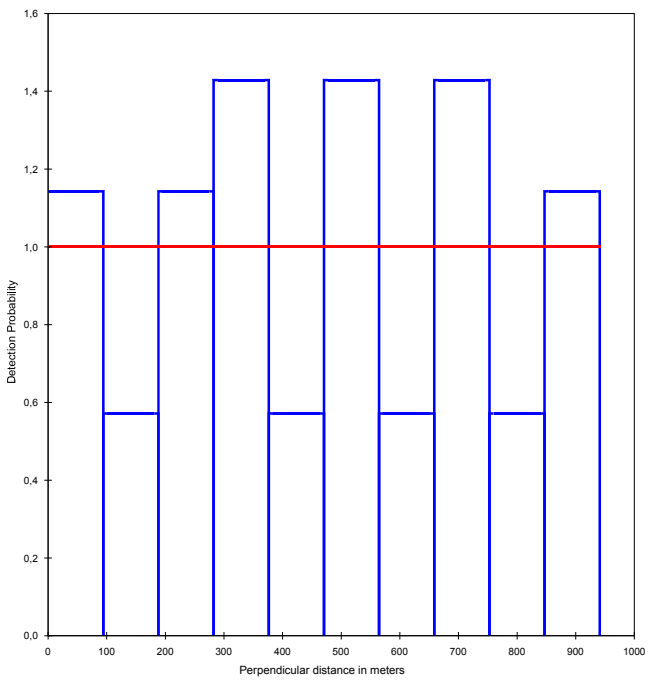

Figure 7. The probability of detecting an elephant in relation to its perpendicular distance from the road. Note the lack of a shoulder compared to figure 7. The red line represents the modelled detection curve as in figure 7.

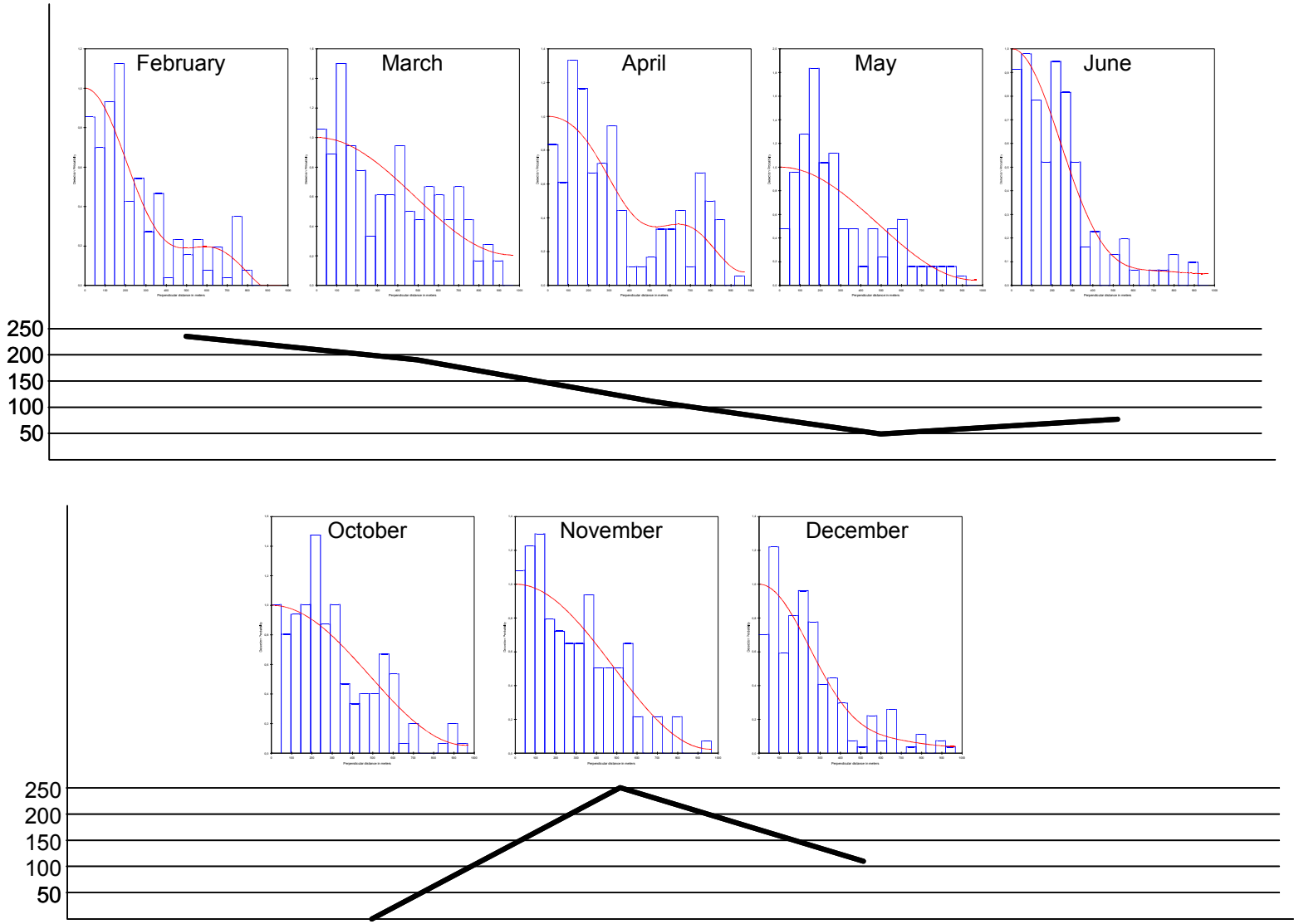

Figure 8. The animals observed avoidance from the roads exhibited per surveyed month in relation to the registered number of tourists (the thick black curves). The modelled detection probability is indicated by a red curve as in figure 7. The leftmost axis indicates the number of tourists.

Animal behaviour when spotted from the survey vehicle

Carnivore (cheetah, lion, jackal and hyena) behaviour in this respect (being approached by survey or tourist vehicles) was observed on 39 occasions. The normal behaviour exhibited by a carnivore when first spotted from the survey vehicle was either walking or running (Figure 9). This supports the assumption that animals start moving away from their initial position when they sense an approaching vehicle. Only rarely were other behaviours observed.
-

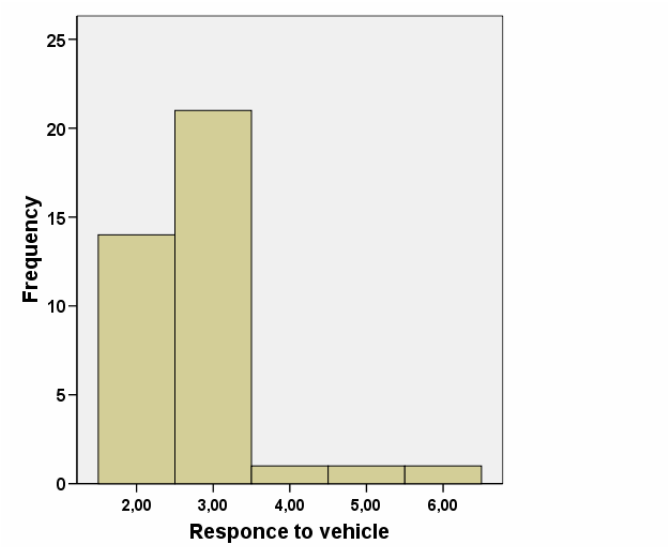

Figure 9. Carnivore (cheetah, lion, jackal and hyena) behaviour when spotted from the survey vehicle. 2 = running, 3 = walking, 4 = stalking, 5 = feeding, 6 = resting

Stalking (cheetah), feeding (hyena) and resting (lion) were observed on three occasions respectively. On 6 occasions carnivores were observed when tourists were watching them from vehicles (Plate 1). Two solitary cheetahs were seen running away on two occasions surrounded by 10 and 16 vehicles respectively. Another cheetah was seen stalking with one vehicle nearby. The tourists were viewing the cheetahs for about 10 to 25 minutes. One lion pride was observed running away when approached by one vehicle and another pride was also seen running when approached by two vehicles. Two lions were seen walking when being close to four vehicles.

On one occasion a lion pride was observed when being congested by several tourist vehicles. The pride responded by moving and this initiated a movement in a nearby buffalo herd that shifted 200 meter away from the pride. On another occasion (Seneto road) the presence of 4 vehicles (for more than two hours) close by a lion pride might have reduced their feeding rate as it was observed that one female lion hunted warthog and after a while started feeding without the presence of her cubs as they were on the next side of the road shielded by tourist vehicles. This might have reduced the feeding rate for her cubs. The presence of vehicles created a shade that attracted cubs to lie underneath for about 40 minutes. After a while the driver decided to start the car and roar the engine creating a big noise as the means of scaring and chasing them away and when the fourth car then arrived, the cubs run away from the pride indicating fear. Then the whole pride changed its behaviour from resting to moving and stopped at a distance of about 200 meter away from the road, thus leaving the kill exposed to scavenging by other animals.
Tourist vehicles have been observed to delay female rhino from returning to calves, which increases the risk of neonatal mortality. On several occasions ungulates were observed interrupting their feeding close by the road and running away as tourist vehicles passed by at a high frequency.

- **Evaluation of the findings in relation to the working impact hypotheses**

IH 1.1: Congestion of tourist vehicles affects the activity pattern of endangered species

The general pattern of land use exhibited by carnivores and herbivores in general is that they tend to occur more frequently some 100 to 200 metres away from roads than close to roads. Apparently there was no synergy between the number of tourists and/or vehicles entering the crater and the observed degree of avoidance exhibited by the animals. The exact reason for this observed avoidance is not obvious. It might be that animals react to vehicles and start to move away from the road when they sense a disturbance and thus will be detected in their new position farther out and not in their initial position closer to the road. Alternatively, animals keep a permanent distance from roads as they have experienced that roads mean frequent disturbances. Other possibilities are that the environment close to roads is contaminated with emissions from vehicles or that dust from the roads reduces palatability of grass and browse close to the road (Ndibalema et al. in prep.).

There are also some indications suggesting that endangered species might be affected by traffic along the roads in the crater. Carnivores in general were walking or running when observed during surveys and some cheetahs were seen running when tourist vehicles were nearby. This might indicate an avoidance response to vehicles and it can therefore interfere negatively with their energy-balance. Lions were seen reacting to vehicles in a manner that affected a nearby buffalo herd. This can have consequences for both species as buffalos might be disturbed more than usual and their awareness towards lions might increase and thus reduce hunting success of lions. However, we can not rule out that the buffalo response in fact was a reaction to the vehicle as well.

Black rhino cows have been observed to delay their returning to calves after being disturbed by vehicles. This might affect survival of calves as they could be exposed to increased predation and possibly getting reduced opportunities for suckling. The large number of vehicles in the Crater not only disturbs rhino but also compromises the tourism experiences (Mills et al, 2006). We have no evidence for elephants being disturbed by vehicles and tourist traffic. Elephants are therefore probably less affected than the other species in this regard.

According to our data there is no evidence that tourism has affected population sizes of ungulates and carnivores in the crater. The populations of wildebeest, zebra, thomson's and grant gazelle, buffalo and hartebeest are close to those reported by Runyoro et al. (1995). The only exceptions from this trend are warthog and ostrich which our analyses suggest have relatively higher population sizes than reported by Runyoro et al. (1995). Our estimates suggest 300 individuals for both species whereas Runyoro et al. (1995) reports about 115 warthogs (although with considerably variation) and around 30-40 ostriches. According to the present estimation, lion numbers are still low around 58 individuals. Although being a very uncertain estimate it is close to the 60 individuals reported by Kissui and Packer (2004). This suggests that the lion population in the crater still struggles to reach its carrying capacity of about 100 to 120 individuals (Kissui and Packer, 2004). Because our estimate for hyenas is only half of the population size (150 vs. 300) reported by Hoofer et al. (1999), one could have expected that lions would have benefited from decreased competition from hyenas and thereby increased its population growth. It is therefore likely that the lion population still suffers from a long history of disease outbreaks and inbreeding (e.g inbreeding among Norwegian wolfs). The lion population may well be very susceptible to infections due to proximity to a growing human population and increased tourism.

Another question that might have bearings in this respect is the presence of the Maasai grazers in the crater. Their presence might lower the hunting success of the lions as it was reported by one Maasai elder herdsmen that lion prides usually tend to diverge when they came into contact. However this might work in both directions as it was also reported that one Maasai herdsman was injured by a lion in the crater when they interfered.

IH 1.2: Increased congestion of tourist vehicles reduces hunting success per unit effort spent by carnivore and IH 1.3: Congestion of tourist vehicles at a kill will elevate the feeding time of the carnivores increasing inter and intraspecific competition

A restricted amount of data does not allow a thourough analysis of these topics. However, there is some evidence suggesting that tourist vehicles and congregation at kills and during hunting sessions might affect hunting success and feeding time. The finding that carnivores in general were walking or running when spotted during surveys can possibly indicate that they interrupted their activity and started moving due to the approaching vehicle. However, it can not be ruled out that running or walking was their present activity. But since running or walking were much more common than sedentary activities it suggests that their activity pattern was affected by disturbance from vehicles. At times this might implicate that hunting and feeding activities will be affected. On two occasions lion prides were observed to respond to vehicle disturbance in a manner that affected their hunting/feeding behaviour or indirectly the behaviour of nearby ungulates. It is interesting to see that lion response to disturbance from vehicles affects nearby buffaloes. The buffaloes probably responded to an unexpected behaviour from the lions and run for safety. If this is correct it means that a simple disturbance of an animal or species might initiate a kind of cascading affect to other animals/species. There is also ample evidence that congestion of vehicles affected the hunting/feeding behaviour of a lion pride. A lioness killed a warthog in presence of tourist vehicles, but she started feeding without being attended by her cubs which were on the other side of the road so that the vehicles obstructed their access to the kill. Later on the cubs run away from the pride due to a roaring engine whereafter the pride followed and left the kill. This means that feeding rate and hunting behaviour of the pride were affected and scavengers and other carnivores could get access to the kill thus increasing food competition and finally it might expose the cubs to increased predation.

IH 1.5: Spread of zoonotic diseases will be influenced by congestion of tourist vehicles at the picnic sites and thus affect carnivores direct and indirect

There is no data from the present survey, except for tourist and vehicle numbers, that can be used to evaluate this hypothesis. However, it is well known that severe outbreaks of diseases over the last 40 years greatly have affected the crater lions. In 1963 the lions recovered exponentially from the severe outbreak, but three outbreaks between 1994 and 2001 were so densely packed in succession that the population was unable to recover to its carrying capacity. Apparently, the lions are very susceptible to inbreeding and infections due to a growing human population and influx of tourists into the crater (Kiussi and Packer, 2004). Tourists might bring in diseases in several ways and the probability of outbreaks increases generally in proportion with the number of tourists. Diseases might be spread by; walking with infected shoos; feeding the animals (tourists were seen feeding guinea fowls); using open lavatory systems; using open disposal systems; driving with infected tires; throwing waste in the nature; and so on (Arnemo pers. com.). It is therefore important that tourists are not allowed to bring in food and contaminated clothing from other countries. Lavatories and disposal systems must be closed systems to ensure that animals will not get in contact with sewage and waste. Feeding of animals must be prohibited. Also, at the picnic sites, tourists food (fruits with viable seeds) when dropped may in the long run lead to introduction of new plant species in the area.

IH 4.1: Soil erosion causes siltation into water bodies leading to alteration of water quality and quantity

Due to lack of capacity, we did not manage to get any data on water quality and as such we can not evaluate this question soundly. However, we have some observations that can contribute with helpful information regarding this topic. On one survey we recorded 21 vehicles, on average, at a picnic site with a maximum of 170 visitors congested at a single spot (Plate 2). Such congestions are potentially harmful as they might cause soil erosion, water pollution and drainage. Disturbances through heavy traffic during the dry season near Lake Makati caused soil erosion and resulted in siltation. Absence of sign posts to indicate the actual distance from the water bodies' edge and vehicle parking points might encourage drivers to encroach more towards the lake, hence causing habitat destruction by reducing vegetation cover around the lake. Absence of functional road sign posts along the Seneto road near Goose pond resulted in

trespassing by tourist vehicles. Delayed maintenance of roads in the crater might apparently encourage off-road driving in an effort to achieve better wheeling (Plate 3).

GENERAL RECOMMENDATIONS

The short duration and limited amount of data for this survey gives a snapshot of the present situation in the crater. We can not detect trends developing over time or generalize our findings as universally valid for the area. However, we have detected some patterns which should be acknowledged and given attention. We suggest that the following recommendations should be notified:

- There is a need to conduct regular monitoring of the animal populations in the crater (to enable predictions of long term population developments) to assess more firmly possible impacts of tourism activities on the environment, ecology and health of the habitat and animal community.
- NCAA should (on a regular basis) inform stakeholders, tour operators and hotel companies about ecological effects of tourist activities on sensitive habitats and endangered species.
- There should be a call for a NCAA management strategy to channel and control the number of tourist vehicles entering the crater per day and the amount of time spent per sighted carnivore surrounded by vehicles.
- NCAA should consider to minimize activities near sensitive areas such as Ngoitoktok spring and Lerai forest
- NCAA should provide closed lavatory and disposal systems and measures to mitigate spread of zoonotic diseases

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- **APPENDICES**

LIST OF PLATES

Plate 1: 5 vehicles congested close to lions.

Plate 2: High vehicles congestion at Ngoitoktok spring picnic site.

Plate 3: Delaying of Crater roads maintenance will encourage off-road driving which leads to vegetation destruction and environment degradation.

7.2 Impact assessment report form

Basic information obtained through: 1. General information; and 2. Work conducted in connection with the EIA on human aspects and on ecological aspects in the NCA.

VEC:		**Time:**	
		Area:	

1 Screening of impact dependent factors

Impact dependent factors	Yes	No	Comments
1. The VEC must be in the area where the impact factor occurs. Factor 1: *Representation (time in the area)*.			
2. The VEC must have the possibility to come in contact with the impact factor. Factor 2: *Exposure (probability of contact with the impact factor when the VEC and the area overlap).*			
3. The impact factor must have an effect on the VEC. Factor 3: *Influence (probability of effect if in contact).*			If yes, list valid impact factors.

Potential impact on the VEC requires a positive value (yes) on each of the factors

Vulnerability dependent factor 4 will be assessed through point 2 below.

2 Assessment of impact significance

IH no.	**Valid impact factor (from 3 above):**	**Category**
Impact hypothesis:		

Scale parametres										
Spatial scale			**Temporal scale**			**Impact magnitude**			**Score**	**Impact level**
LI	**R**	**N/I**	**S**	**M**	**L**	**S**	**M**	**L**	**Product of S, T and P**	Low/Medium/High

Rationale:

Scale parameters

Three scale parameters for assessing the significance of the impact on each VEC, measured through B and C hypotheses, were used: Spatial scale, temporal scale and impact magnitude. Each of the scale parameters consists of three categories (adapted from Indian and Northern Affairs Canada 1992b and Thomassen et al. 1999):

Value	Spatial scale [1)]	Time scale [2)]	Impact magnitude [3)]
1	Local impact	Short term	Small
2	Regional impact	Medium term	Moderate
3	National/international impact	Long term	Large

1) Spatial scale:
Local impact: The effect/impact is on a large proportion of a single relatively independent and unconnected resource or value. Other, similar resources or values may or may not exist in the region, but these are unaffected if they do exist.
Regional impact: The effect/impact is on a group of similar resources or value. Other, similar resources or values may exist in the region, but these are unaffected. Alternately, the effect is on a single resource which has a regional distribution.
National impact: Anything larger than a regional impact.
2) Temporal scale:
Short term: The effect/impact can/will occur over a time period less than one generation of the resource or value being considered. For resources that are defined with the word «quality» such as for example «water quality», it is appropriate to use the generation time of the medium, in this case the water turnover.
Medium term: The effect/impact can/will occur over a time period approximately equivalent to one generation of the resource or value being affected. The «quality» issue described above applies equally here.
Alternatively, recovery of the resource or value after removing the influence of the project activity(ies) will take approximately one generation of the resource or value. The «quality» issue described above applies equally here.
Long term: The effect/impact can/will occur over a time period greater than one generation of the resource or value being affected. The «quality» issue described above applies equally here.
Alternatively, recovery of the resource or value after removing the influence of the project activity(ies) will take more than one generation of the resource or value. The «quality» issue described above applies equally here.
3) Impact magnitude:
Small : The effect/impact cannot be statistically detected (under normal assessment budgets; given enough resources, any can be detected).
Moderate : The effect/impact can be statistically detected and ascribed to the influence of the project.
Large : Statistics are not required to observe the effect/impact.

Each of the scale parameters, with their corresponding categories on a three fold scale, is considered as equal important. A total of 27 combinations of the categories are possible. An Impact level score is obtained by multiplying the category values. We choose a conservative approach to Impact level the potential impact factors:

Score 1, 2, 3, 4: Low (10 combinations). **Impact level = 1**
Score 6, 8, 9: Medium (10 combinations). **Impact level = 2**
Score 12, 18, 27: High (7 combinations). **Impact level = 3**

Possible combi-nations	Score	Impact level
111	1	Low
112	2	Low
113	3	Low
121	2	Low
122	4	Low
123	6	Medium
131	3	Low
132	6	Medium
133	9	Medium

Possible combi-nations	Score	Impact level
211	2	Low
212	4	Low
213	6	Medium
221	4	Low
222	8	Medium
223	12	High
231	6	Medium
232	12	High
233	18	High

Possible combi-nations	Score	Impact level
311	3	Low
312	6	Medium
313	9	Medium
321	6	Medium
322	12	High
323	18	High
331	9	Medium
332	18	High
333	27	High

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