Local Communities' Awareness and Perceptions of Astro-tourism in Tanzania: A Case of Mbozi Meteorite

Reguli Baltazar Mushy
Department of Geography, Tourism and Hospitality Studies,
The Open University of Tanzania
**Author Corresponding Email reguli.mushy@out.ac.tz*

Abstract
Tourism is one of the fastest growing economic sectors and the largest industries in the world. Among the many branches of tourism that this study considers is nature-based tourism, with a particular emphasis on a special interest tourism product referred to as astro-tourism. Astro-tourism focuses on activities related to observing night skies and celestial phenomena in natural spaces, as well as terrestrial meteorites relicts. Astronomical views such as rainbows, beautiful sunsets, sunrises, and astronomical phenomenon such as solar and lunar eclipses can attract many tourists all around the world. In Tanzania, the Mbozi Meteorite (*kimondo*) is emerging as an opportunity for tourism destination in the country. The main objective of this study was to assess local communities' perceptions and awareness of Mbozi meteorite as one of the aspects of astro-tourism. A mixed research approach with questionnaires, in-depth interviews and observations was used to collect data from 110 respondents who were randomly selected for the study from local communities/villages in the neighbourhoods of Mbozi meteorite site. 15 key informants were purposefully selected from Songwe region including local community leaders/elders, tourism entrepreneurs (Agents, tour guides, shopkeepers, curio, art & crafts), and government officials. Both descriptive and thematic analyses were used to analyze quantitative and qualitative data. Findings revealed that the local community members are aware of the presence of *kimondo*, and they associate it with varied taboos and traditions. Further they noted that despite being there for decades, it is just of recent that *kimondo* has attracted attention and attracted a number of visitors and tourists. The number of tourists has increased in the locality hence bringing up new opportunities and threats. The study recommends for community education and involvement in tourism activities that will improve their livelihoods.

Keywords: *Astrotourism, Meteorite, Emerging Tourist attractions, kimondo, local communities*

INTRODUCTION

Tourism is one of the most important sectors in stimulating economic growth across different countries globally, promoting sustainable development and generating employment (Owusu & Siaw, 2015). According to the World Travel and Tourism Councils' economic report (2013/2014), in 2013 tourism industry supported 8.9% of the total employments across the global. It is the third-largest export category (after fuels and chemicals) and in 2019 accounted for 7% of global trade. For some developing countries such as East African countries, it can represent up to 20% of their GDP and, overall, it is the third largest export sector of the global economy (UNWTO, 2020).

In Africa, tourism is also an important income-generator where about a third of all direct tourism GDP in 2018 was attributed to wildlife (WTTC, 2019). It provides foreign exchange, employment, incomes and public revenue. It is one of the top five sources of foreign currency for 83% of developing countries. WTTC (2020) stated that, the industry is important for many least developed African countries such as Madagascar, Rwanda, Tanzania and Uganda - where the wildlife tourism sector is important for economies and livelihoods.

In Tanzania, tourism is among the fastest growing economic sectors and one of the largest industries in the country (Mamadi, 2004); estimated to account for about 12.2% of the country's workforce, 17.5% country's GDP and 25% of the foreign currency (Kideghesho *et al*., 2021). Tanzania is predominantly of wildlife nature (MNRT, 2002) which attracts the tourists, the foreign exchange earnings for an economy and also generates other economic benefits which include income, employment and revenues (Kweka *et al.*, 2003). The government of Tanzania views tourism as a significant industry in terms of job creation, foreign currency generation and poverty alleviation (MNRT, 1999). The tourism sector is receiving greater attention than ever before from government and international development agencies (MNRT, 1999).

Tourism has many branches and faces to include wildlife tourism, nature based tourism and cultural tourism to mention a few (Damijanić & Sergo, 2013; Huang, Li, & Cai, 2010). Among the many branches of tourism that this study considers is nature-based tourism, with a particular emphasis on a special interest tourism product referred to as astrotourism. Astrotourism, as for other forms and components of tourism is a service industry which relies on two forms of knowledge (Eagle, 2014), namely, the knowledge (local knowledge) of the night sky, also referred to as ethno-astronomy (Holbrook,

Medupe, & Urama, 2008), and an appreciation for the night sky in the modern scientific paradigm (Soleimani *et al*., 2019). Thus, it can be argued that the night sky is not the product being sold, but knowledge.

Since time immemorial, human beings in their different cultures have been inspired by the night skies (Collison & Poe, 2013). Indigenous cultures across the world have been influenced by the stars and their arrangements on the sky, and have used the positions of the stars for agriculture and navigation. Star gazing has traditionally been associated with different cultural values and beliefs. In modern times however, the majority of celestial objects are no longer visible to more than 50% of the world's population who live in cities, obscured by light pollution. This has led to the global rise of a new branch of sustainable, nature-based (rural) tourism referred to as astrotourism (Soleimani *et al*., 2019).

Astrotourism is viewed and defined differently by different scientists. Spennemann (2008) defines astrotourism as 'the travelling of private individuals to specific locations to satisfy a desire to view the planets and stars either unaided (naked eye) or with the aid of an optical device, e.g. telescope'. However, this definition lacks the breadth of the astrological experience and the spiritual connection that astro-tourists can experience when gazing at the night sky. Cater (2010) referred astrotourism as space travel, neglecting terrestrial (land based) astrotourism in his definition. Ingle (2010:4) refers astrotourism as 'creating a tourism asset from nothingness', one could argue that the night sky is far from nothing as the universe is inextricably linked to life on this planet. In contrast, Collison (2012) viewed the phenomenon of stargazing as people travelling to a destination where dark skies, free from artificial light pollution, can be enjoyed, naming it astronomical tourism or simply astrotourism, a simple but accurate description of the activity. Najafabadi (2012) refers astronomical tourism as the potential of sites to attract astro-tourists to a particular destination, focusing on the destination rather than the activity. Although stakeholders have always looked at the stars, stargazing as a tourist activity is relatively new and has been largely overlooked by the academic community, rendering the need to explore the behaviour and experiences of this hitherto neglected emergent tourist (Fayos *et al*., 2014). Weaver (2011) further elaborates on the idea that astrotourism is a type of ecotourism through activities which are focused on observation and appreciation of celestial phenomena. Kanianska *et al*. (2020) agree with this idea and add that since its greatest assets don't need maintenance and development and are always available and unique, it is one of the most sustainable forms of tourism (Soleimani *et al*., 2019).

According to Tapada *et al*. (2021), Astrotourism comprises of recreational and/or educational activities which are developed around the cosmos, astronomical phenomena and the ways of understanding them, both past (e.g. cosmogonies, mythologies, etc.) and present, including the latest scientific findings as well as the instruments and technologies that astronomers use in astronomy nowadays. Astrotourism provides a sustainable and meaningful tourism experience, aligning with the conservation of natural resources and cultural heritage in situ (Dowman, 2019). It can be implemented at minimal cost, requiring little infrastructure – stargazing can be done with the naked eye for free, or with binoculars which are not too costly (Buckley, 2020). Astrotourism also offers opportunities for science education, sharing indigenous knowledge, and active participation, enriching both the tourist and benefiting host local communities (Tosun & Jenkins, 2016). For these reasons, astrotourism contributes to several of the UN's Sustainable Development Goals (SDGs) (United Nations, 2015). Moreover, astronomy's universal appeal attracts a diverse audience, ranging from scientists and amateur astronomers who deliberately plan visits to dark sky areas, to the general public encountering astrotourism experiences serendipitously (Buckley, 2020). Such activities may include stargazing, eclipse chasing, astrophotography courses, and visits to observatories, International Dark Sky Places (IDSPs), or archaeo-astronomical sites (Dowman, 2019). In the context of this study, Astro-tourism focuses on activities related to observing night skies and celestial phenomena in natural spaces, as well as terrestrial meteorites relicts such as the Mbozi meteorite.

Astrotourism is one of the different types of tourism that the countries offer (Soleimani *et al*., 2019). It not only allows people to learn Astronomy while travelling, but also offers travelling for relaxation. It does not only offer daytime tour where you can enjoy different activities under the sun, but also lets you experience a new activity under the light of the moon and billions of stars. According to Fletcher (2017) Astrotourism offers opportunities for hands-on learning and skill development; and in collaboration with local schools and educational institutions, it can foster appreciation for science and astronomy among community members. Astrotourism makes use of unpolluted nightscapes as a natural and infinite resource. As dark skies become scarcer, many countries in the Global South including Tanzania have a unique opportunity to offer their dark skies to travellers who seek to reconnect with the heavens.

In addition to observing celestial phenomena in the night skies, astrotourism encompasses activities related to the observation of terrestrial meteorite remnants, including meteoroids, shooting stars, and meteorites. A meteoroid refers to a particle of debris in the Solar System, ranging in size from sand to boulder, that collides with Earth (Brown et al., 2002). The visible trajectory of a meteoroid entering Earth's (or another celestial body's) atmosphere is termed as a meteor, commonly known as a shooting star or falling star (Brown et al., 2002). If a meteoroid reaches the ground and endures the impact, it is classified as a meteorite (Brown et al., 2002). Instances where multiple meteors appear within seconds or minutes are designated as meteor showers (Yeomans, 1991). Etymologically, the term 'meteor' finds its origins in the Greek word meteōros, signifying 'high in the air' (Harper, 2021). A meteorite is a solid fragment of debris from an extraterrestrial object, such as a comet, asteroid, or meteoroid, originating in outer space and surviving its passage through the atmosphere to impact the surface of a planet or moon (Nehru et al., 2017). In essence, a 'Meteorite' is a rock in the Solar System that collides with Earth and withstands the impact (Nehru et al., 2017).

There are millions meteorites that have fallen on the earth surface (Dietz, 1994; Nehru *et al*., 2017, Brown *et al*., 2002). The largest meteorite recorded by astronomers in the Hoba Meteorite which is found in Namibia, weighing about 66 tonnes (Figure 1.). Mbozi meteorite in Tanzania is the 8th in the list.

Figure 1: World's Largest Meteorite, Hobba Meteorite
Source: Dietz, H. (1994)

Different cultures have different perceptions of the meteorite. Hindus for example traditionally believed that the meteorites are nothing but the forms of those who fall to be reborn after having enjoyed the fruits of their meritorious deeds in Heaven. They are divided into five categories viz.

Ignescent Balls, Meteors, Thunder-bolts, Lightning and Shooting Stars (Comets) (Subba-Rao, 2020).

Tanzania, renowned for its diverse tourist attractions encompassing natural wonders, cultural heritage, and historical and archaeological sites, is home to gems like the Mbozi Meteorite. These attractions, including the Mbozi Meteorite, draw significant interest from the international tourism markets. The contemporary fascination with the cosmos has given rise to Astrotourism, as stakeholders increasingly delve into the mysteries of the universe. Jiwaji (2016) notes that Tanzania's strategic geographical location and its skies free from light pollution make it an ideal destination for astro-tourist activities, seamlessly integrated into the existing tourism offerings. The Mbozi Meteorite, affectionately known as "kimondo," is gradually gaining recognition as a promising tourism asset for the country. Despite its potential, it is noteworthy that Tanzania currently lacks a formalized astrotourism industry, underscoring the need to gauge community awareness on astrotourism, particularly emphasizing the Mbozi meteorite. The primary objective of this study is to evaluate the perceptions and awareness of local communities regarding the Mbozi meteorite as a crucial aspect of astrotourism.

METHODOLOGY

Mbozi District (where the meteorite is found) is one of the districts in Songwe Region, Tanzania. It is located at the south western part of Mbeya Region, between latitudes 8^{o} and 9^{o}12' south of the Equator and Longitudes 32^{o}7'30'' and 33^{o}2' East of the Greenwich Meridian. It shares borders with Mbeya district to its eastern part, Ileje district to the south, Momba district to its western part and Chunya district to the north, and to the west by Rukwa Region. The major ethnic groups in terms of their number are the Nyiha, who account for over 50% of the total population. The other ethnic groups are Nyamwanga, Wanda, Nyakyusa, Ndali, Lambya, Malila, and Safwa. The major socio-economic and income generating activities in the district include agriculture, livestock production and marketing, conservation and harvesting of existing natural resources and small industrial production.

Mbozi Meteorite ranks as the world's 8th biggest, is situated some 65 kilometers southwest of the town of Mbeya City, in Mbozi district, and weighs about 25 metric tons. It is approximately 3 meters long and 1 meter tall. The Mbozi Meteorite is the most well-known tourist attraction in the Songwe area, located at Latitude: -9° 06' 60.00" S and Longitude: 33° 03' 60.00" E.

Figure 2: The Mbozi Meteorite (*kimondo*)
Source: Field Study, 2023

A meteorite is a piece of extraterrestrial material that was big enough to prevent being entirely consumed when it entered the atmosphere of Earth (Nehru *et al*., 2017). However, the piece is tiny enough to escape exploding; just about a third of the estimated 500 meteorites that enter the earth each year hit land, and only about 10 are detected and documented (Nehru *et al*., 2017). Locals have known about the Mbozi Meteorite, which they name Kimwondo or kimondo, for generations, but the lack of legends about its quick and unmistakably fiery arrival suggests that it happened long before the current residents arrived, over a millennium ago. Only the tip of the meteorite was visible when it was formally found in 1930. The slope around the Mbozi Meteorite was excavated to show the entire meteorite, leaving a pillar of earth behind it that was subsequently strengthened with concrete to act as a plinth. The uneven notches on its pointy end were formed by souvenir seekers chopping chunks off — no simple work considering the strength of the meteorite's nickel-iron composition (Mbozi Meteorite Project, 2021).

Unlike most meteorites which are made up of stony-irons or silicates, the Mbozi meteorite is unique due to the fact it is mostly made up of iron (90.45%), nickel (8.69%) and with minor quantities of copper, phosphorus, and sulfur (Mbozi Meteorite Project, 2021).

A mixed research approach with questionnaires, in-depth interviews and observations was used to collect data from 110 respondents who were randomly selected for the study from local communities / villages in the neighbourhoods of Mbozi meteorite site. 15 key informants were purposefully selected from Songwe region including local community leaders/elders, tourism entrepreneurs (Agents, tour guides, shopkeepers,

curio, art & crafts), and government officials. Both descriptive and thematic analyses were used to analyze quantitative and qualitative data.

RESULTS AND DISCUSSIONS

Demographic characteristics of respondents

Socio-economic and demographic characteristics of respondents are presented in Table 1. Results revealed that majority of respondents (52.7%) of respondents were males. Most of respondents (30.9%) were aged between 30-39 years, and more than four fifth were aged between 20 and 49 years. In terms of education level, 44.64 had primary education and about a third (32.14%) had O-Level education. Findings further revealed that majority of respondents (41.9%) engaged on farming as the main economic activity, followed by petty/small businesses. Demographic characteristics of respondents largely determine and influences their perceptions and awareness to astrotourism.

Table 1: Socio-economic and Demographic Characteristics of respondents

Gender of Respondents	**Frequency**	**Percent**
Male	58	52.7
Female	52	47.3
Age of Respondents	**F**	**%**
Below 20 years	5	4.5
20-29	22	20
30-39	34	30.9
40-49	27	24.6
50-59	13	11.8
60+	9	8.2
Marital Status	**F**	**%**
Married	74	67.3
Single	25	22.7
divorced	3	2.7
widow	8	7.3
Education Level of respondents	**F**	**%**
Not educated	8	7.14
Basic primary education	50	44.64
O-level education	35	32.14
A-level education	3	3.56
College education	11	9.82
University	3	2.7
Main Occupation of respondents		
Farmers	46	41.9
Business	39	35.2
Public servant	17	15.2
Entrepreneur	3	2.9
Pastor	5	4.8

Source: Field Survey,2023

Findings revealed that majority of respondents (local community members) (98%) are aware of the presence of *kimondo*, and they associate it with varied taboos and traditions.

Perceived Use of Kimondo

Majority of respondents (59.1%) reported that they use Kimondo for traditional rituals such as praying for fortune, praying for success in their business as well as healing (Figure 1). On the other hand, 23.7% and 23.4% use the meteorite for learning as well as businesses respectively.

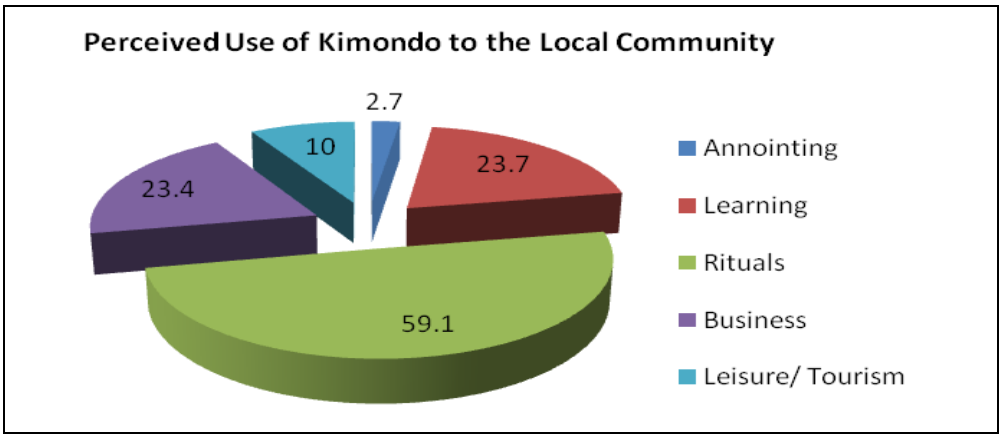

Figure 3: Perceived use of Kimondo by the local community

It was further reported most local people in the surroundings and far away, visit the meteorite to make prayers for different requests from God and ancestors. One key informant reported:

> *'My friend was suffering from unknown disease, and after visiting traditional healer, he was advised to visit the meteorite and make some rituals there. After the rituals he was healed and up to now he is well and pays visit the meteorite once in a while'.*

Another elderly respondent said:

> *'in the earlier days when we were still young, elders in our clan used to visit the meteorite site to offer sacrifices and make prayers. When there was any ailment or a problem in our area, elders would visit and make prayers, and the problem ended'.*

Thus, it is evident that the indigenous local communities surrounding Mbozi meteorite use it for traditional rituals. Some Local people visit *Kimondo* with beliefs that they will get good luck and succeed in business and other livelihood activities. Sometimes traditional practitioners/doctors' advices them to visit and make prayers at the Kimondo and offer sacrifices.

Perceived benefits of Mbozi meteorite to local communities

Respondents were asked of their perception on whether the presence of Mbozi meteorite in their locality to be beneficial (an asset) or loss (liability). About two thirds of respondents (65.4%) were of the view that the meteorite was an asset rather than a liability (Figure 2). Only about 7.3% were not comfortable of the meteorite in the area and considered it as a liability. 18% were not sure whether the meteorite was beneficial or not.

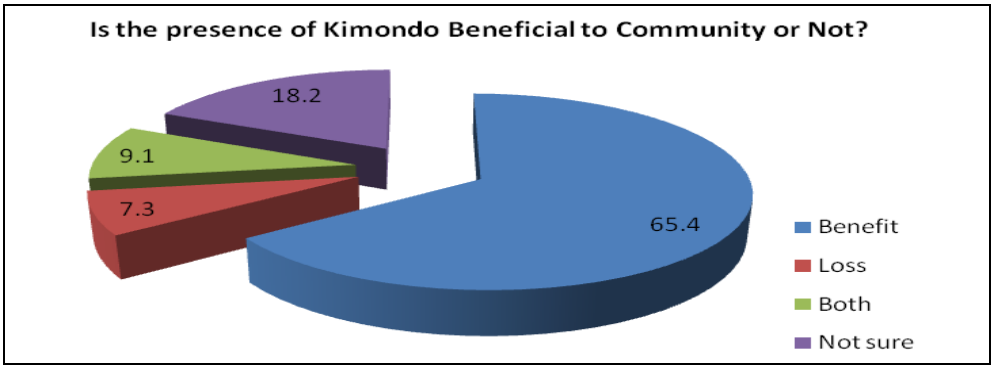

Figure 4: Whether the presence of meteorite is beneficiat or not

Regarding the benefits that local community get from the presence of the meteorite, majority of respondents (60%) argued that social services has improved tramendously due to the presence of the meteorite. These include Water supply projects, road maintenance project, electricity supply project, environmental conservation, and constuction of a museum (Figure 5, Figure 6). One third of respondents (34%) reported to have improver their bussinesses due to the presence of the meteorite in their local area (Figure 5). Insignificant number of respondents were of the view that they benefit through interaction of different people/ tourists who visit the meteorite, hence increasing their networks.

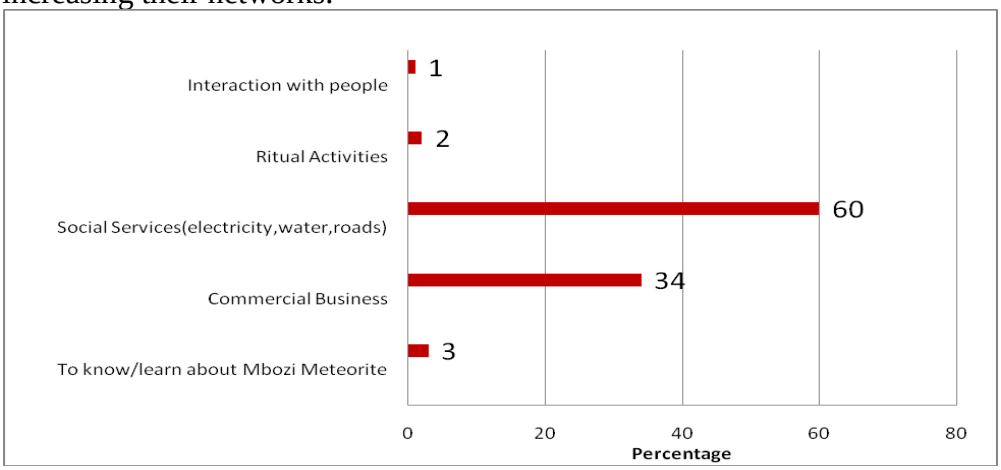

Figure 5: Benefits of *Kimondo* to Local Community

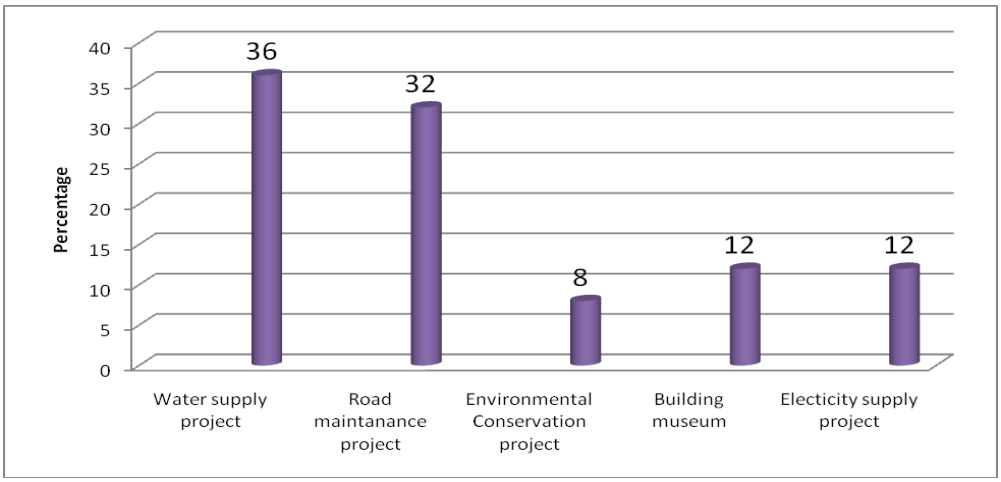

Figure 6: Social services facilitated by the presence of the Mbozi meteorite

Perceived Threats / Worries Due to Presence of the Meteorite

Apart from the benefits highlighted by majority of respondents, some respondents had some worries/threats that may be associated with the presence of the meteorite. There are presented in Figure 7.

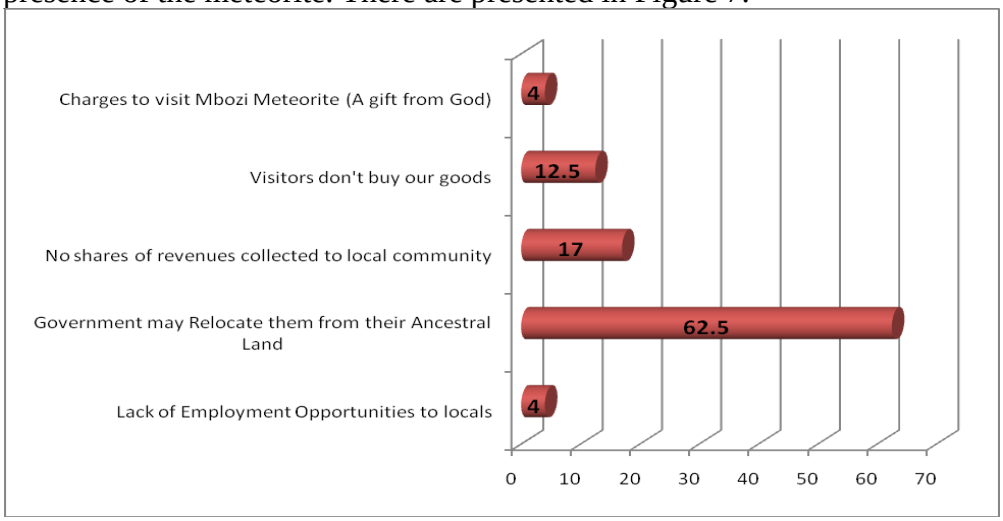

Figure 7: Perceived threats associated with the meteorite

About two thirds of respondents (62.5%) were worried that with the improvements in the meteorite site, they may be relocated from their ancestral lands. This worry is associated with rumours that the site will be expanded to provide adequate services to cater for astrotourism services. And as such they will be denied of their land and traditional rights for the meteorite. One respondent exclaimed:

> *'this meteorite is ours, we inherited it from our ancestors, it is our ancestral land. We are however compelled to pay entrance fee just to pay visit to our own heritage!!'*

Another respondent argued that:

> *'We have seen what happened recently in Ngorongoro District, where the local Maasai were evicted from their ancestral lands in the Ngorongoro Conservation Area and were relocated to Msomera village in Handeni district. Similar cases were also reported in Loliondo, where the local people were forcefully evicted from their ancestral lands in the name of conservation of wildlife and natural resources. The same authorities that supervised the eviction are now in Mbozi meteorite site. It is no wonder in the near future we will also be evicted from this land in the name of meteorite conservation and development'.*

From local people's perspectives, it is evident that despite the many benefits brought by *kimondo* recently, there is also an increase of fear among the locals of their ancestral lands.

These findings are in line with Buckley (2019) who argues that the influx of tourists and infrastructure development may pose challenges to the delicate ecosystems in dark sky regions. Consequently, their potential for night sky observation may be jeopardised. Mitigation strategies must be in place to minimize environmental footprints. Additionally, astrotourism initiatives should be sensitive to local cultural norms and practices. Collaborative planning with communities is crucial to avoid cultural commodification and ensure respectful engagement of the local communities (Dolnicar *et al*., 2021).

Perceived Improvements to Attract More Tourists in Mbozi Meteorite Site

Despite the benefits and worries relating to Mbozi meteorite site, respondents were of the view that the site has not attracted tourists compared to other sites in the country. 38.5% of respondents proposed for more publicizing of the Mbozi meteorite through different media such as television, radio, social media and other means (Figure 8). About a third (31%) proposed for improvements in the social services such as tarmac road to the site, as well as establishment of the camping site astrotourism night observations. In addition, education and public awareness campaigns about Mbozi meteorite and involvement of the locals in the conservation of the meteorite site was paramount.

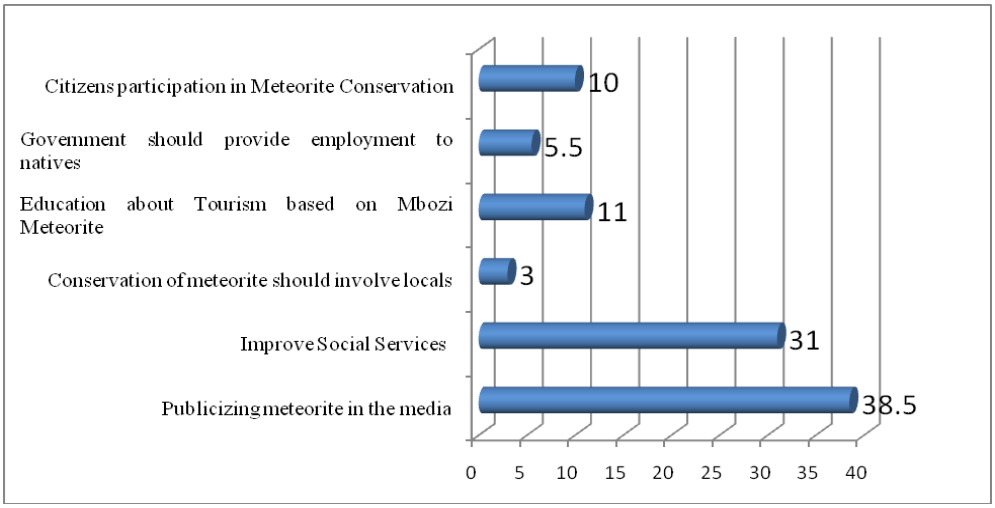

Figure 8: Areas for improvements

There is a need for the government to work together with the local community in Mbozi to take advantage of astrotourism potential available through Mbozi meteorite site and make improvements of services to visitors. It was noted that there is no even a water kiosk close to the site let alone other services. Local tour guides need to be involved while promoting and marketing tourism services in the southern highlands of Tanzania. Muloin, Timmons, & Murphy (2015) argue that successful astrotourism initiatives require active involvement and participation from local communities. Lack of community engagement may lead to resistance or conflicts.

The Mbozi meteorite site currently lacks essential tourist services, including hotels and guest houses, to accommodate and cater to visitors who come to explore the meteorite and other tourist attractions. This deficiency leads to the perception among many tourists that necessary services are distant from the meteorite sites, dissuading some from visiting altogether. Consequently, this situation hinders the influx of tourists, causing both the Ngorongoro conservation area and local communities to miss out on valuable foreign currency. It is imperative for the management to address and rectify this issue in the near future.

CONCLUSION AND RECOMMENDATIONS

The Mbozi meteorite is under the preservation and conservation of Ngorongoro Conservation Area. However, the local community involvement in the process of preservation and conservation has not adequately been taken into consideration. The findings of this study revealed that local community members were aware of the presence of the Mbozi meteorite in their area and

had different perceptions on its use for various ways. They had observed a number of benefits accrued from the presence of the meteorite including different projects aimed at improving social services in the local area. However, they were still worried of their fate regarding their ancestral lands.

Astrotourism presents a celestial opportunity for local communities to harness economic, cultural, and educational benefits. To ensure its sustainability, stakeholders must adopt a community-centric approach, involving residents in planning, decision-making, and benefit-sharing. Balancing the economic advantages with environmental and cultural preservation is essential for the long-term success of astrotourism ventures.

It is recommended therefore that the government through Ngorongoro Conservation Areas Authority (NCAA) should put in place security system for the meteorite and visitors who visit the site. Also, NCAA should promote the presence of Kimondo at Mbozi in Ndolezi village through different means such as the social media, so as to get more visitors/ tourists and hence increase incomes of the local community. Apart from preserving the meteorite, NCAA should put in place telescopes for sky observations. This will attract more visitors, both locals and from outside the country to learn more about astronomy and astrotourism. Lastly, it is equally important to involve local communities and other stakeholders when it comes to sensitive issue expanding the site for developmental purposes to avoid conflicts with the community as has been observed in other parts.

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