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Modelling the impact of geo-tourism on geo-conservation of Hell's Gate National Park in Kenya

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Abstract

Purpose – The purpose of this paper is to model the impact of geotourism on geoconservation by observing two popular geotourism activities, namely, rock climbing and hiking. It proposes that as much as geotourism activities have potential negative impacts, they can also bring about positive modification of critical ecosystems like that of Hell's Gate National Park.

Design/methodology/approach – This research opted for an exploratory research design using both open and close-ended questionnaires from 351 respondents and was complemented by documentary analysis. The statistical relationship between geotourism activities and geoconservation was modelled through linear regression.

Findings – As predicted the computation using hiking and rock climbing to predict geoconservation were significant with $p = 0.004 < 0.05$ and $p = 0.002 < 0.05$, respectively. Implying that selected geotourism activity(s) are positively related to geoconservation

Practical implications – Recognizing the symbiotic relationship, values and relevance of geotourism to geoconservation as a dynamic approach to preservation of protected area management is central to promoting ecosystem stewardship and contributes to the achievement of United Nations development goals.

Originality/value – This paper fulfils an identified need to study how geotourism activities can be used to preserve/conserve the ecological environments and geoheritage of a destination

Keywords Environmental impacts, Hiking, Protected area management, Rock climbing

Paper type Research paper

1. Introduction

Tourism is seen as a key pillar in the development of Kenya as envisioned in Vision 2030 [Government of Kenya, GOK (2007)]. Geology and landscapes are everywhere and they have created interest and have become geotourism attractions (Nazaruddin, 2019). Kenya's wild safaris and other forms of tourism are enriched by the geological formations and therefore cannot be complete without a geological tour. Because of the complex relationship between tourism and the ecological environment, it is necessary to preserve and conserve her natural

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resources. This is why the concept of geoconservation has become a global phenomenon (Grenard *et al.*, 2019).

Geodiversity is acknowledged as part of the natural diversity by International Union for Conservation of Nature and as a result given weight to geoconservation and has subsequently been incorporated in the principles of protected area management (Gordon *et al.*, 2017). The appreciations of geological resources are important to geotourism. It fosters the understanding of and connection with geological features through visitation, interpretation and education. This destinations, therefore, requires planning and appropriate development to prevent adverse impacts geotourism may cause on geological attractions as a result of ineffective management (Szepesi *et al.*, 2016).

Geotourism is a recent phenomenon based on geology, geomorphology and landscapes (Boskov *et al.*, 2015). Several attempts have been made to define geotourism. From the Greek word "geo" which means "earth" it can be defined as tourism of the earth. It is a form of tourism that when one thinks of aesthetic value, cultural-heritage of place and its surrounding, geographical attributes come to mind (Abioui *et al.*, 2018). Furthermore, geotourism can be defined as a specialized form of tourism whose main focus are geosites and champions sustainable tourism (Dowling, 2013; Ngwira, 2019). Some forms of geotourism activities include but are not limited to; hiking/leisure bush walks, rock climbing, which are subjects of this study.

Geodiversity and biodiversity come together to form unique landscapes that are considered tourist attraction. Making them key element of geotourism (Mokhtari, 2014). Geosites and landscapes are everywhere, whatever activity a tourist has, be it cycling, hiking, the experience will be enriched with geological features. A large number of tourist activities can take place elsewhere but recreational hiking and camping take place in protected area settings such as woodlands and/or wilderness (Tribe, 2000). What enhances these activities or what makes them worthwhile is the natural surroundings. The challenge, therefore, is that in the process of consuming tourism potentially undesirable effects on the environment can occur (Wall and Mathieson, 2006). The pressure on the ecosystem is as a result of overuse by visitors thereby magnifying the chances of negative environmental impacts occurring between the resources (protected area) and the product (geotourism). However, tourism can be seen to have helped protect the environment.

The nature of geotourism dictates the use of geological landscapes that carry living things. It will be wrong then to ignore the fact that while geoconservation deals with the conservation of the abiotic parts of the natural environment, it plays a significant role bio conservation. That is to say, biodiversity is dependent upon geodiversity. Geotourism should be able to play a significant part in preventing the degradation of landforms, soil and water that will adversely impact on the biological species and communities living in or on them (Sharples, 2002). Recognizing the symbiotic relationship, values and relevance of geotourism to geoconservation as a dynamic approach to preservation and maintenance of protected areas management is central to promoting ecosystem stewardship and contribute to the achievement of United Nations development goals. In Kenya, protected areas such as national parks, reserves, sanctuaries and conservancies are guided by policies clearly set forth with the intentions of conserve and manage wildlife (GOK, 2014). Through the Wildlife Act of 2014, conservation efforts are based on the concept of sustainable utilization of wildlife resources derived from land use to ensure that their value and management do not decline. [World Wildlife Fund, WWF (2014)].

With this, comes the contemporary trends in nature conservation and tourism activities that argues that the focus should not only be on the conservation of living things but also non-living or abiotic nature resource elements (Solarska *et al.*, 2013). The assertion that

geoconservation may not be necessary because of the robust nature of the earth's features is far from the truth. To maintain the value and sustainability of natural environments there is need for full integration of geoconservation and nature conservation into broader nature conservation programme. The sensitivity of geodiversity through misconceived to suggest that no special management of geodiversity is necessary. Their aesthetic, recreation, historical, sense of place are geological features worth protecting for future generation Sharples (2002).

2. Materials and methods

2.1 Description of study site

Hell's Gate National Park is one of the most highly developed parks in Kenya and has relatively long-term history of both recreational visitation and wildlife-based tourism. Established in 1984 as a protected area, Hell's Gate National Park, an ideal and popular place for weekend getaways and retreats, provides a variety of wildlife, unusual flora and many species of birds and is one of the only two Kenyan parks where rock climbing at the towers and cliffs is permitted. Other activities include hiking on trails at the Gorge, Obsidian caves, Hell's kitchen, Narasha and Hobley Volcano, Cycling through the park, camping at the public campsites and filming (Kenya Wildlife Services [KWS], 2019). Because of the environmental set, that is the rocks towers and cliffs, trails and gorges, flat grounds and increasing need for rest and rejuvenation by people, Hell's Gate National Park has been able to provide support for active recreation.

Hell's Gate National Park is a small park, approximately 68 km^2. It is located between Naivasha, Longonot and Suswa at an altitude of 1,560 m^2,187 m (4,680 ft–6,561 ft) above sea level. It is an ideal venue for retreats outside busy urban areas as it is 100 kms from Nairobi and 56 kms from Nakuru and 10 kms from Naivasha town (Magical Kenya, 2014). The park provides a variety of active recreation activities such as rock climbing, nature walks, biking and camping which are the focus of this study.

2.2 Data analysis

In this study, an assessment of how geotourism activities are associated with geoconservation and the strength of the relationship is done so as to establish how these factors relate to each other. Ultimately, the interest is to predict the outcome from two geotourism activities herein known as predictive factors that is rock climbing, hiking. The statistical relationship between geotourism activities and geoconservation was modelled through linear regression. All independent variables were assigned symbols as shown and explained in the formula below to allow for regression analysis to take place. The prediction model was developed based on effects that have already been recorded and then used to predict the subsequent effects as far as the impacts of geotourism activities were concerned.

Therefore, the general form of a prediction equation from multiple regression was:

$$Y' = \mu + b_1X_1 + b_2X_2 + A + \varepsilon$$

where Y' is the predicted impact, X_1 is the impact of the first predictor variable which is hiking, X_2 is the impact of the second which was rock climbing, The Y-intercept is A. The regression coefficients (b_1, b_2, etc.) are analogous to the slope in simple regression, $\propto$ is constant.

Specifically, Y represents geoconservation.

X^1 represents hiking.

X_2 represents rock climbing.

3. Results

3.1 Modelling geotourism activities and geoconservation

To ascertain the variability of relationships between the dependent (geoconservation) and independent (hiking and rock climbing) variables. The hypotheses tested was:

3.1.1 Hiking.

H0. Respects of indigenous heritage, protection of biological diversity, respects the philosophy of "Leave no Trace", cutting corners on zigzag paths and creation of new paths in every expedition tourist make does not have some impact and use in geoconservation at Hell's Gate National Park vs

H1. Respects of indigenous heritage, protection of biological diversity, respects the philosophy of "Leave no Trace", cutting corners on zigzag paths and creation of new paths in every expedition tourist make at least has some impact and use in environmental conservation at Hell's Gate National Park.

3.1.2 Rock climbing.

H0. Respects of indigenous heritage, protection biological diversity, respects the philosophy of "Leave no Trace", significance in wildlife management and supports wilderness preservation does not have some impact and use in environmental conservation at Hell's Gate National Park vs

H1. Respects of indigenous heritage, protection biological diversity, respects the philosophy of "Leave no Trace", significance in wildlife management and supports wilderness preservation at least do have some impact and use in environmental conservation at Hell's Gate National Park (Table 1).

As predicted from the Table 1 below, the computation using hiking to predict geoconservation was significant with $p = 0.004 < 0.05$. Therefore, at 5% level of significance, indicating reject the null hypothesis and conclude that respects of indigenous heritage, protection of biological diversity, respects the philosophy of "Leave no Trace", cutting corners on zigzag paths and creation of new paths in every expedition tourists make have some impact and use in geoconservation at the Hell's Gate National Park. Furthermore, the computation using rock climbing to predict geoconservation was significant with p-value of $0.002 < 0.05$ meaning at 5% level of significance, we reject the null hypothesis and conclude that respects of indigenous heritage, protection of biological diversity, respects the philosophy of "Leave no Trace", significance in wildlife management and supports wilderness preservation does not have some impact and use in environmental conservation at Hell's Gate National Park.

An overall test of hypothesis to further ascertain the variability of relationships between the combined dependents variable (geotourism activities) and independent variables (geoconservation). The hypothesis of interest being:

Table 1. Modelling separate geo-tourism activities and geo-conservation

Model		Sum of squares	df	Mean square	*F*	Sig.
Hiking	Regression	3.764	5	0.753	3.531	0.004[a]
Rock climbing	Regression	28.338	5	5.668	3.785	0.002[a]

Notes: [a]Predictor: hiking, rock climbing; [b]dependent variable: geoconservation construct

H0. Hiking, rock-climbing, does not have any impact and use in geoconservation at Hell's Gate National Park vs

H1. Hiking, rock-climbing, have some impact and use in geoconservation at Hell's Gate National Park.

Table 2 below, indicates a p-value, $p = 0.001 < 0.05$ which is highly statistically significant. Therefore, at 5% level of significance, we reject the null hypothesis and conclude that hiking, rock climbing, have some impact and use in geoconservation at Hell's Gate National Park.

3.2 Modelling existence of relationship between variables

Multiple regression analysis was used by the researcher not only to establish the existence of relationships between the variables but also to determine the strength of causal relationships between dependent that is geoconservation and geotourism activities which included hiking and rock climbing.

To bring out the relationship between geotourism activities (independent variables) and construct (the dependent variables), multiple regression equation was computed to model as shown in equation one below:

- $Y=\beta_0+\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_4x_4+\beta_5x_5+\varepsilon_{ij}$ was used.

where

Y is the dependent or criterion variable (*geoconservation construct*).

β_0 is the constant value.

The independent or predictor variables are:

X_1 – Respects indigenous heritage (RIH).

X_2 – Contributes to the protection of biological diversity (CPD).

X_3 – Respects the philosophy of "Leave no Trace" (RLT).

X_4 – Rarely cuts corners on zigzag paths (RZP)/has a significance in wildlife management (SWM).

X_5 – Creates new paths in every expedition they make (CPE)/supports wilderness preservation (SWP).

β_1, β_2, β_3, β_4 and β_5 are the regression coefficients and $\boldsymbol{\varepsilon_{ij}}$ is the error component with mean zero because normality has been assumed.

The findings from Table 3 below, shows that for hiking only three out of five factors were found to be statistically significant, namely, the CPD (p-value = 0.045 < 0.05) and RLT (p-value = 0.011 < 0.05) and RZP (p-value = 0.011 < 0.05). The findings however found RIH and CPD not to be statistically significant at 5% level of significance.

Rock climbing, shows that only the two out of five factors are statistically significant, namely, the RLT (p-value = 0.002 < 0.05) and SWM (p-value = 0.017 < 0.05). The findings

	Sum of squares	df	Mean square	*F*	Sig.
Regression	208.232	44	4.733	6.861	0.001[a]
Residual	211.056	306	0.690		
Total	419.288	350			

Note: [a]Predictors: (constant)

Table 2.
Modelling combined geotourism activities and geo-conservation

however found RIH, CPD and SWP not to be statistically significant at 5% level of significance.

3.3 Overall multiple regression model for geotourism activities and geoconservation

Besides running a multiple regression analysis for each of the two independent sub-variables (each having five factors), multiple regression analysis as a general model to establish the existence of relationships between the variables to determine the strength of causal relationships between dependent (geoconservation constructs) and independent variables (hiking and rock climbing).

The multiple regression equation to model the two factors using the following model:

- $Y=\beta_0 + \beta_1 x_1+\beta_2 x_2+\varepsilon_{ij}$ was used.

where

Y is the dependent or criterion variable (geoconservation constructs).

β_0 is the constant value.

The independent or predictor variables are: X_1 is cycling, X_2 is rock-climbing.

β_1 and β_2 are the regression coefficients and ε_{ij} is the error component with mean zero because normality has been assumed.

Based on the table above, the multiple regression analysis for the dependent versus independent variables generated the equation as shown below:

$$\text{Environmental Constructs} = 1.033.+.0.078(\text{Cycling}) + 0.096\,(\text{Rock} - \text{climbing})$$

The findings from Table 4 above shows that both factors are statistically significant hiking (p-value = 0.041 < 0.05) and rock-climbing (p-value = 0.012 < 0.05) at 5% level of significance.

Table 3. Modelling existence of relationship between variables

Model	Hiking (Sig.)	Rock climbing (Sig.)
Respect of indigenous heritage	0.052	0.057
Contribution to the protection of biological diversity	0.045	0.032
Respect the philosophy of "leave no trace"	0.011	0.002
Rarely cut corners or zigzag paths	0.011	–
Creates new paths in every expedition	0.715	–
Has significance in wildlife management	–	0.017
Supports wilderness preservation	–	0.216

Table 4. Overall multiple regression model

Model	Unstandardized coefficients		Standardized coefficients	T	Sig.
	B	Std. error	β		
Constant	1.033	0.216		4.792	0.000
Cycling	0.078	0.038	0.109	2.048	0.041
Rock climbing	0.096	0.038	0.131	2.519	0.012

4. Discussion

Protected area managers are tasked with the responsibility of environmental management and this calls for appropriate pro-environmental geotourism behaviour (Bissix *et al.*, 2020). Geotourism activities such as respect for indigenous knowledge, protection of geo and biodiversity and leave no trace, encourage environmental awareness and lead to pro-environmental behaviour designed to have minimal impact on the ecosystem or even benefit it (Kollmuss and Agyeman, 2002; Steg and Vlek, 2009; Ars, 2014).

Despite the overwhelming nature of geo and biodiversity conservation, there are positive areas especially where people's support is concerned (Kraus, 2017). Most people who enjoy hiking seek beautiful, natural environments to hike and are always aware of its fragility to some degree. However, while the action of an individual may not strongly affect the environment, the mass effect of a large number of hikers can degrade the environment (Durham, 2017). Per year, the ecosystem provides services worth $125tn to humans and the increased awareness of the benefits of hiking and spending time with nature is advancing the need for conservation (Sala, 2020). Hell's gate ecosystem has largely been shielded from major negative impacts due to the fact that the protected area has designated routes and trails for hikers (Kenya Wildlife Services [KWS], 2019). The results showed a significant positive contribution of hiking as a geotourism activity to geoconservation efforts. Consequently, measures aimed at protecting the geological environment should take into consideration the positive and negative impacts and maximize on the positive while minimizing and eliminating the negative impacts.

Largely, because of the strenuous nature of rock climbing, the population of climbers is small (Sarah, 2006). Rock climbers prefers natural rock formations, the goal is to reach the summits from predefined routes. Often done intentionally referred to as cleaning, new routes are created at the same time environmental damages (Reighart, 2007). The waste and visible abundance of chalk that climbers use is of environmental concern in the parks but are potentially amendable and manageable (Eling, 2005). However, with time rock climbers, conscious of the importance of conservation and preservation have adhered to and therefore carry out minimal impact climbing practices (Kooner, 2018). There is a positive relationship between awareness of minimum impact practices (Clark *et al.*, 2020). Rejecting the null hypothesis suggests that rock climbing has a significant contribution to geoconservation and in the long run, addressing issues that might change the ecosystem positively and negatively should be done. Consequently, this means that geotourism activities impact geoconservation thereby requiring the managers of protected areas to consider the use of this activities in the support and protection of the ecosystem for its sustainability.

5. Conclusion

As predicted, geotourism activity(s) was positively related to geoconservation, with well over half of the variance in geoconservation accounted for by its relationship to geotourism activities. The results imply that those working in the management of protected area, particularly in areas where active geotourism activities such as hiking and rock-climbing, should not make sweeping generalizations about geotourism activities and their impact on geoconservation. While both geotourism activities models presented provided valuable predictions of the impact of varying geoconservation practices at the Hell's Gate National Park, geoconservation may be severely limited considering the impacts of current development such as encroachment of horticultural firms, pollution and competition for the scarce water and land resources. As a protected area controlled by existing laws, recognizing the link between geotourism activities and geoconservation and the encroachment of

horticultural facilities could be considered fully within current management plans. Knowing more about such activities may help protected areas and professionals to develop programs which increase geoconservation. While there is no much negative impacts accrued from this activities at the moment there is a risk of allowing the activities to go on as they are without taking into consideration measure to protect the ecosystem for future use, thereby slow degradation due to increase in the influx of recreationists will start and eventually cause massive damage due to mass tourism. More visitors are attracted to protected areas like and this comes with economic benefits but also adverse impacts on the ecological environment. This study, therefore, recommends a further study on the equity of awareness and application of pro-environmental behavioral practices of geotourists in protected areas.

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