

Original Research Article

Implication of Changing Climate on Tourism Development in Southern Tanzania

Abstract

East Africa tourism is one of the most successful sectors in the Sub-Saharan Africa, mainly attributed to the diverse natural landscapes and biological resources, creating special tourism assets. However, despite its importance, the tourism industry, particularly in the southern circuit of Tanzania, has been significantly affected by climate change impacts. The effects of climate change have been detrimental to both the environment and socio-economic activities such as loss of species, disturbances to the timing and patterns of tourism seasons, and disruptions to various tourism facilities and activities. This study examines the impacts of climate and non-climatic factors on tourism development in southern circuit of Tanzania focusing on Ruaha-Rungwa ecosystem. The study adopted a mixed-method approach that uses both secondary and primary data collected through interviews and field observations. Data analysis was done using EXLSTAT and Mann–Kendall Trend Analysis to analyse climate trends. SPSS was used to analyse quantitative primary data, while content and thematic analyses were used to analyse qualitative primary data. This study found that climate change impacts have negatively affected tourism development in the study area, largely related to eruption of wildlife diseases and decline of wildlife population, loss of revenue attributed to early closing of tourism seasonality, destruction of infrastructures such as the tourist amenities, invasive species domination, and scarcity of water sources for wildlife. Further, non-climatic factors, such as budget constraints, inadequate investments, poor infrastructure, and uncompetitive position, has observed to hinder the development of tourism activities. The low development of the tourism activities in the area can be attributed to low adaptive capacity of the stressed ecological processes to support provision of ecosystems goods and services. The study recommends that in averting the impact of climate change on tourism development, both climatic and non-climatic stressors must be effectively considered during the planning processes.

Keywords: Climate change impacts on Tourism, Tourism development, tourism resilient and adaptive measures, Southern circuit of Tanzania

1. Introduction

Tourism serves as a powerful driver for both direct and indirect economic expansion, particularly in developing nations, generating over 8% of global employment [1,2] and contributing to more than 10% of the world's Gross Domestic Product [2]. In 2011 tourism generated about 2.6% of the GDP of countries in Sub-Saharan Africa and directly and indirectly accounted for more than 12.8 million jobs of the region [2]. In East African countries, tourism sector has shown to have a substantial and growing impact as a critical economic driver in East African countries [3]. Tanzania is one of the countries that are endowed with abundant natural resources and the most diverse natural landscapes and biological resources [4,5,6]. It has the highest percentage of Protected areas (PAs) coverage worldwide, with more than 600 PAs, a coverage equivalent to about 38% of country's total land area [6]. This accounts for potential tourism asset as well as important areas for wildlife conservation. The nation has been ranked as 4th among 140 countries in terms of its abundance of natural resources relevant for tourism [1].

Being a nature-based tourism country [5,4] it attracts a significant number of tourists from different parts of the world, which increases its shares to the National GDP as well as supporting over 11% of the total employment within the country [7]. Despite this potential of the tourism growth in the Tanzania, the sector growth is heavily concentrated in the parts of Tanzania whereby majority of tourists visit the destination for wildlife safari packages [7, 8]. According to [8], the northern national parks of Serengeti, Tarangire, Kilimanjaro Mountains and Arusha National Parks receive large numbers of tourists as compared to southern circuit. National Parks in southern Tanzania are reported to attract only 10% of Tanzania total park visitors, hence the area is mentioned to be underutilised when thinking of tourism growth and contribution to the GDP [7].

Although Tanzania as a country has been increasingly benefiting from the ongoing tourism growth [9], the benefits have not been equally realised by all tourist circuits such as the southern circuit of Tanzania [8,7]. Despite its vast endowment of tourism assets, which includes opportunities for wildlife safaris, hiking, cultural tourism, hunting and other tourism activities in the region, Southern circuit of tourism Tanzania lagged behind with respect to tourism growth which is partly contributed by climatic challenges [10, 9,11] as well as non-climatic stressors [7]. Changes in the climatic condition are emerging as one of the key challenges threatening the sustainability of tourism development [12,13].

Although knowledge on the nexus between climate change and tourism is emerging [10], many researchers have been facing challenges in quantifying the effects of climate change on the tourism sector [10,11] as well as quantifying the massive climate change mitigation and adaptation gaps [14,15,16]. In this regard, most of the past studies [10,11] indicate that direct effects of climate change and variability on tourism will be driven by major climate variables, such as temperature, precipitation, humidity and storm frequency on cultural facilities and natural resources that bear tourism value. For example, it has been indicated that climate, tourist visits, and wildebeest migration are closely related [11]. Generally, climate change has direct and indirect effects on tourism resources in the destinations, policy framework, tourism development and sustainability [17].

Other challenges are linked to the interconnectedness of the direct and indirect effect of climate change [18], relative to other non-climate factors that affect tourism, such as policy development [17]. A wide range of climate-induced environmental changes will have profound effects on tourism across scales [19-22]. Changes in water availability, biodiversity loss [23], reduced landscape aesthetic values, increased natural hazards, coastal erosion and inundation, damage to infrastructure and the increasing incidence of vector-borne diseases will all impact tourism to varying degrees [24].

While there is some progress regarding ecotourism and climate change knowledge, there are still many uncertainties about how various climate parameters and non-climatic factors will affect the tourism sector and its activities [24]. Tanzania in particular tourism and climate studies have increased in the last decade yet there are still considerable sectoral knowledge gaps on tourism development in the context of climate change impacts and non-climatic factors, making it challenging to adopt concrete resilient measures for the sector [10, 26, 27]. Therefore, this study aims to reduce this scientific gap. The study examines tourism development in the context of climate change impacts in the Southern circuit of Tanzania, using Ruaha- Rungwa ecosystem as a study case.

2. Materials and Methods

The study conducted in two protected areas of Tanzania namely Ruaha National Park and Rungwa Game Reserve, known as the Ruaha-Rungwa Landscape (RRL), which offers diverse tourism activities such as photographic safaris, bird-watching, fly-camping safaris, night drives, and hunting, despite its lesser-known nature-based tourism attractions [7].

This study employed a cross-sectional research design with a combination of both quantitative and qualitative methods [28, 29]. Quantitative research methods involved spatial analysis techniques and surveys to assess the impacts of changing climate on tourism development in Ruaha-Rungwa ecosystem. A total of 234 households were surveyed to assess the climate change impacts and a review trends and linkages to tourism development in the study area.

Qualitative research methods (interviews, focus group discussions, and observation) were adopted to assess the beliefs, opinions, and attitudes regarding the implications of climate change on livelihood. Purposive sampling method was employed to select a total of 110 key informants for in-depth interviews to examine actors' awareness and perception [29] regarding tourism development in the context of climate change and variability. Further, purposive sampling method was employed to select 44 participants for focus group discussion in the study villages. The focus groups consisted of influential people, elders, pastoralists, farmers, traditional leaders, women, village game scouts, and natural resource committee representatives.

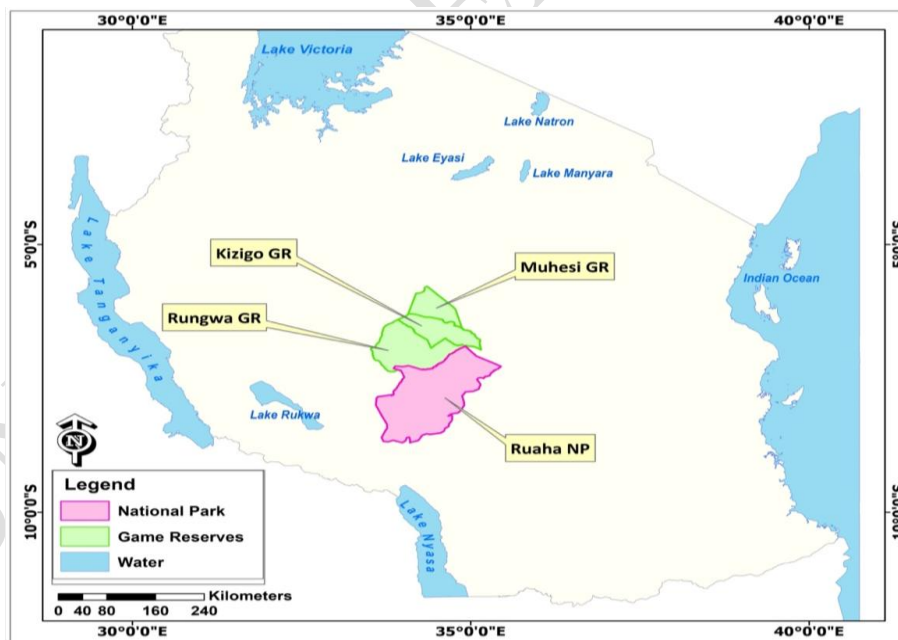


Figure 1: Map of Tanzania showing the study area (Ruaha-Rungwa Landscape), **Source:** IRA GIS Lab, (2021)

The Tanzania Meteorological Agency (TMA) collected rainfall and temperature data from two stations,

Msembe and Rungwa, from 1987-2018 to establish trends and variations, based on the availability of long-term data.

The study utilized IBM SPSS Statistics version 20 to process quantitative data from questionnaires, conduct univariate and bivariate data analysis, and compute cross-tabulation and chi-square to test relationships between variables.

The relationships between variables were tested using cross-tabulation and chi-square (χ^2) using SPSS (equation 1).

$$\chi^2 = \sum [(O - E)^2 / E] \dots\dots\dots (1)$$

Where: Σ denotes the sum across all cells of the contingency table.

O represents the observed frequency in each cell.

E represents the expected frequency in each cell, assuming the variables are independent

Qualitative data from focus group discussions and in-depth interviews were analyzed using content and thematic analysis methods. The analysis was divided into three levels: description, classification, and connection [31]. Transcription and annotation were crucial for the classification stage of the data.

The study categorized data into themes like tourism development's impact on climate change, analyzed it into related categories, established connections between themes, and used corroborative evidence to substantiate interpretations and increase the validity of arguments.

The study categorized data into themes like tourism development's impact on climate change, analyzed it into related categories, established connections between themes, and used corroborative evidence to substantiate interpretations and increase the validity of arguments. The study utilized ArcGIS, EXLSTAT, and Microsoft Excel to analyze data on rainfall and temperature variations. Non-parametric statistical procedures, such as Thiel Sen's slope estimator and MK trend test, were used to identify trends [32]. A linear model was used to assess community perceptions of climatic variables, categorized as "yes" or "no" over 30 years. The variables included stable seasonal rainfall, adequate rainfall amounts, reliable or unreliable onset of rainfall, reliable or unreliable cessation of rainfall, increasing temperature, and decreasing temperature.

3. Results and Discussion

3.1 Climate change and variability patterns, awareness and perceptions

3.1.1 Respondents' general awareness to climate change and variability

The study analyzed the awareness of changing climate in local communities using a Generalized Linear Model (GLM) (Figure 2a and 2b) and binomial logistic regression. The results showed that the best explanation for awareness was the combination of occupation and age. Agro-pastoralists, businesspeople, and crop farmers were found to be more aware than employed people and pastoralists (Estimate = -1.599 ± 0.752 SE, $Z = -2.126$, $P = 0.034$) (Figure 2a). Age also increased awareness, but not significantly (Estimate = 0.051 ± 0.035 , $Z = 1.430$, $P = 0.153$) (Figure 2b). The study highlights the importance of understanding and addressing climate change awareness.

The study reveals that climate change awareness varies by occupation, with vulnerable groups, such as crop farmers and agro-pastoralists, being more aware of the impacts of climate change. Vulnerable communities to impacts of climate change are more aware of it than those who are less vulnerable [33].

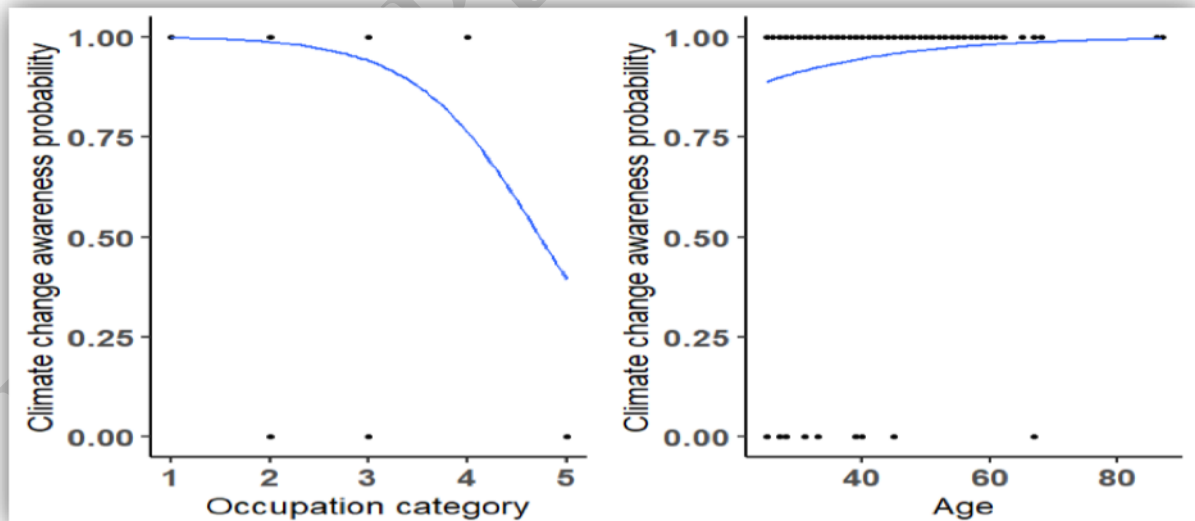


Figure 2: Local communities' awareness level over the changing climate for the past 30 years as explained by respondent occupation (a) and age (b). (Occupation categories; "1" indicates

agro-pastoralists, “2” indicates businessmen, “3” indicates crop farmers, “4” indicates employed people, and “5” indicates pastoralists). **Source:** Field survey data, (2021)

Similar study found that pastoralists in Northern Tanzania have low awareness of climate change trends, possibly due to their migration and reliance on crop farming [34]. Other study findings indicate that while elders have a higher awareness of climate change, age is not a significant factor [35], suggesting under-representation of pastoralists' perspectives in their area.

3.2.2 Respondents' perceptions of climate change and variability

Findings from the household interviews and focus group discussions correlated with the results from the key informants' interviews. Results from a generalized linear model (GLM) with binomial error distribution indicated a significant decrease of trend of stable rainfall seasons (estimate = -0.046 ± 0.007 SE, $Z = -6.706$, $P < 0.01$), adequate rainfall (estimate = -0.096 ± 0.087 , $Z = -10.90$, $P < 0.01$), reliable cessation of rainfall (estimate = -0.011 ± 0.009 , $Z = -1.212$, $P = 0.226$), and decreasing temperature (estimate = -0.061 ± 0.008 , $Z = -8.160$, $P < 0.01$) over the past 30 years. Reliable onset of rainfall decreased insignificantly (estimate = -0.004 ± 0.007 , $Z = -0.620$, $P = 0.535$). Similarly, there was significant increase of trend of unreliable onset rainfall (estimate = 0.139 ± 0.014 , $Z = 10.07$, $P < 0.01$), unreliable cessation of rainfalls (estimate = 0.124 ± 0.012 , $Z = 10.41$, $P < 0.01$), and increasing temperature (estimate = 0.061 ± 0.007 , $Z = 8.544$, $P < 0.01$).

Based on the above findings, the study reveal that reduced rainfall and/or unreliability of rainfall patterns can alter vegetation, water availability and wildlife distribution, impacting tourist attractions. Unpredictable rainfall can cause flooding, erosion, and road damage, hindering tourism development and limiting visitor accessibility within the destination. Unstable rainfall patterns can have profound implications for tourism development, affecting various aspects of the industry from accessibility to the overall visitor experience such as natural attractions and tourists' satisfaction. To maintain attractiveness and adapt promotional strategies, destinations should diversify activities and offer indoor and cultural experiences, ensuring steady visitor flow and enhancing tourism industry resilience.

Sustainable tourism practices are crucial for mitigating environmental challenges like water scarcity, habitat changes and ecosystem disruptions. Prioritizing sustainability involves raising awareness,

implementing responsible practices, and engaging local communities, thereby enhancing resilience to climate variability and preserving ecosystems.

3.2.3 Annual rainfall trends for the period 1980s-2018

The study found no significant difference in annual rainfall between 1989 and 2018, but extreme rainfall occurred in 2009 and 2015-2018 in Rungwa Game Reserve (LM, $F_{(1, 28)} = 3.516$, $P = 0.06$) (Figure 3a) and Ruaha National Park (LM, $F_{(1, 28)} = 1.148$, $P = 0.293$) (Figure 3b), indicating similar patterns of extreme rainfall, has an implication on the large-scale effects on landscapes.

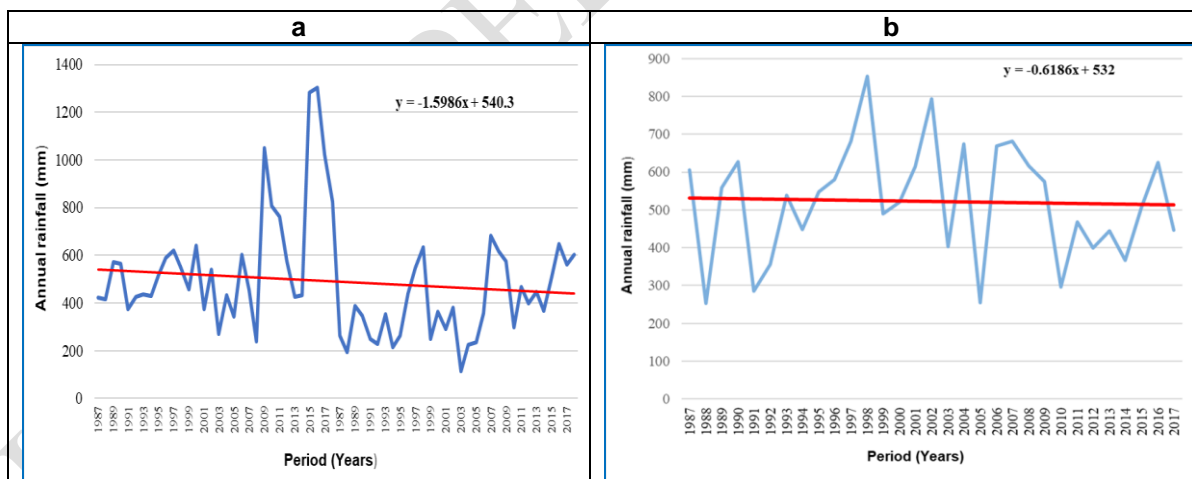


Figure 3: Annual rainfall trends in Ruaha-Rungwa ecosystems; a) Rungwa Game Reserve from the 1980s-2018 and b) Ruaha National Park from the 1980s-2018. **Source:** Field survey data, (2021).

Similar study found a significant decreasing trend in rainfall from 1975-2017 in the Usangu plains [36], while Ruaha National Park experienced extreme rainfall during 2009-2018 similar to Rungwa Game Reserve as confirmed through analysis of rainfall percentage difference (Figure 4). The difference can

be attributed to the Ruaha ecosystem experiencing low rainfall and increased extreme events, which are generally considered increased rainfall.

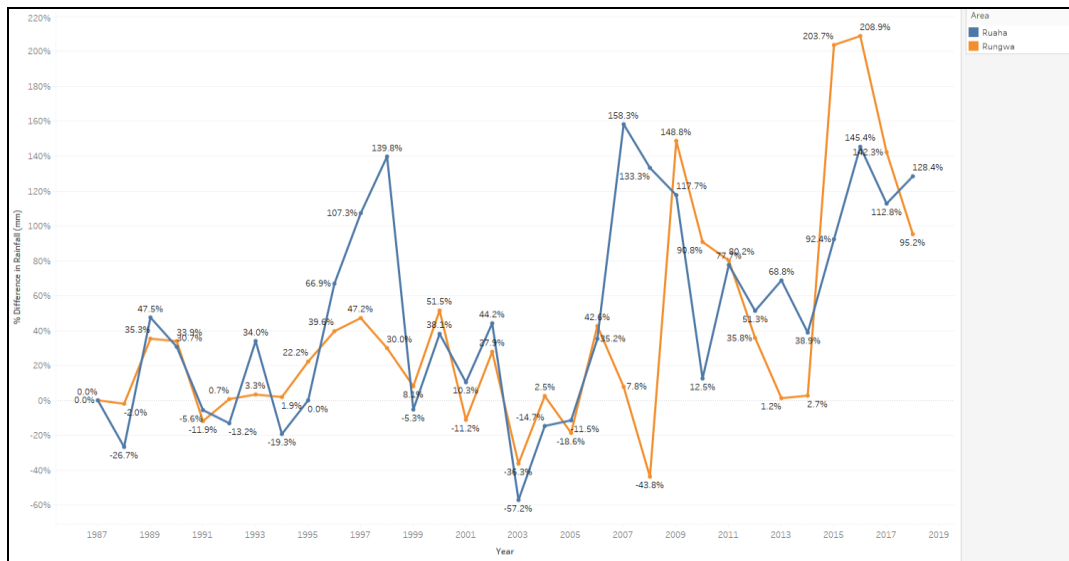


Figure 4: Percentage difference of rainfall received in Ruaha National Park and Rungwa Game Reserve, 1980s-2018. **Source:** Field Data Collection, (2021).

The rainfall percentage differences between two parks, Rungwa Game Reserves and Ruaha National Park, over the past 30 years. Results showed a significant increase in rainfall from 2009 to 2009, with Rungwa Game Reserves receiving 148.8% more rainfall than 1986, and Ruaha National Park experiencing a 116.6% increase (Figure 4).

3.2.4 Annual temperature trends from the 1980s-2018

The study findings Figure 5 (a and b) shows a statistically insignificant increase in annual temperature trends in Rungwa Game Reserve from 1989 to 2018 (LM, $F(1, 28) = 1.881, P = 0.181$), with a significant decrease from 1999 to 2008 (LM, $F(1, 8) = 6.792, P = 0.031$) and insignificant increase from 2009 to 2018 (LM, $F(1, 8) = 2.287, P = 0.169$) (Figure 5a).

These findings indicate that temperature trends in Southern Circuit of Tanzania do not show a significant increase, highlighting the need for ongoing monitoring and conservation efforts. The stability suggests resilience in ecosystems, possibly due to vegetation cover and land use practices. Authorities may need to adjust management strategies by assessing other environmental stressors or anthropogenic factors that may still pose significant challenges that might require attention.

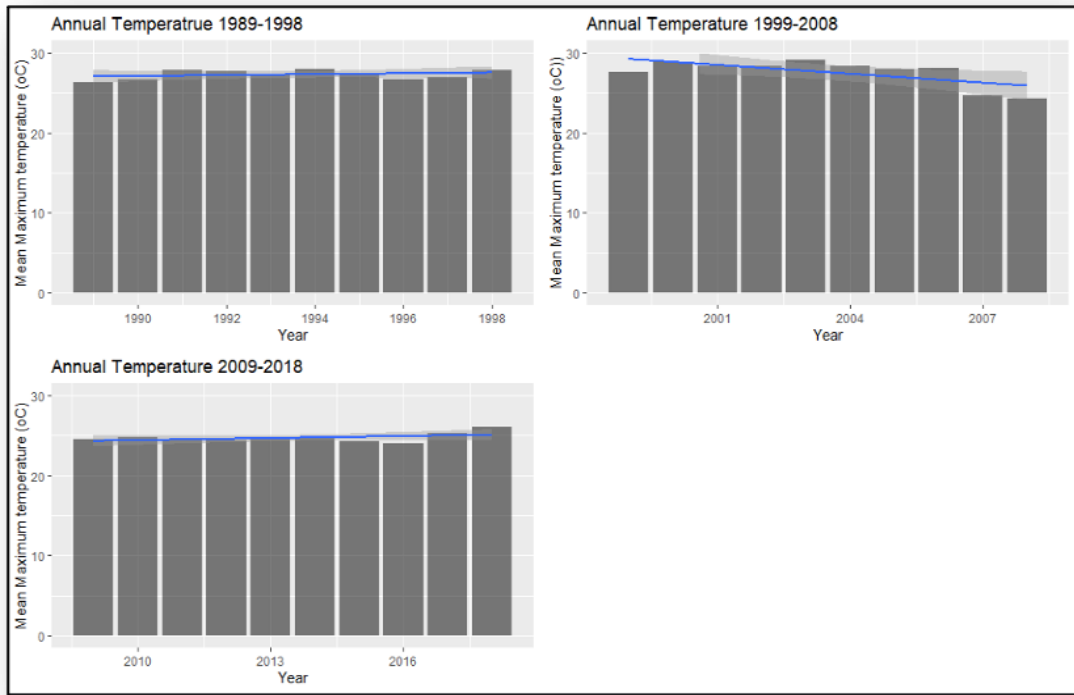


Figure 5a: Annual temperature trends in Rungwa Game Reserve from the 1980s-2018. **Source:** Field survey data, (2021).

Ruaha National Park experienced a substantial reduction in annual temperature from 1989 to 2018 (LM, $F(1, 28) = 2.734$, $P = 0.109$), followed by an insignificant increase from 1989 to 1998 and a significant decrease (LM, $F(1, 8) = 0.764$, $P = 0.408$) from 1999 to 2008. In contrast, there was a notable rise in temperature over the previous 20 years from 2009 to 2018 (LM, $F(1, 8) = 34.74$, $P = 0.0004$) (Figure 5b).

Temperature increase in Tanzania's Southern Circuit, particularly in Ruaha National Park, has disrupted wildlife species' habitats and ecosystems, potentially causing biodiversity decline. This necessitates reassessing conservation strategies and prioritizing habitat restoration and connectivity initiatives. The escalating temperatures also exacerbate human-wildlife conflicts, driven by illegal activities like poaching, fishing, and livestock keeping during climatic extremes.

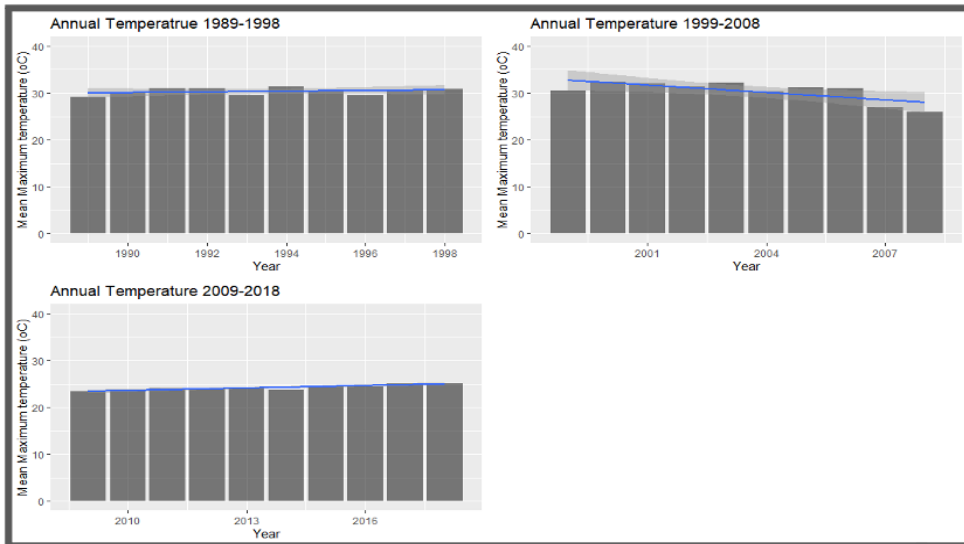


Figure 5b: Annual temperature trends in Ruaha National Park from the 1980s-2018. **Source:** Field survey data, (2021).

Reports of comparable findings in Iringa saw temperature rises between 1980 and 2009 [37], The IPCC predicts a 2-4°C increase by the end of the century, however other study findings indicated that forecast 1.4°C by 2030, 1.7°C by 2050, and 1.6°C by 2080 under the low emissions scenario RCP2.6 [38].

Findings from key informant interview revealed that extreme hot days, especially between August and December, are causing tourists to change game viewing schedules and break during the day, impacting wildlife sightings. Ruaha National Park and Rungwa Game Reserves have experienced significant temperature rises over the past 30 years, with the largest increase in 2016 and the lowest in 2000 (Figure 6).

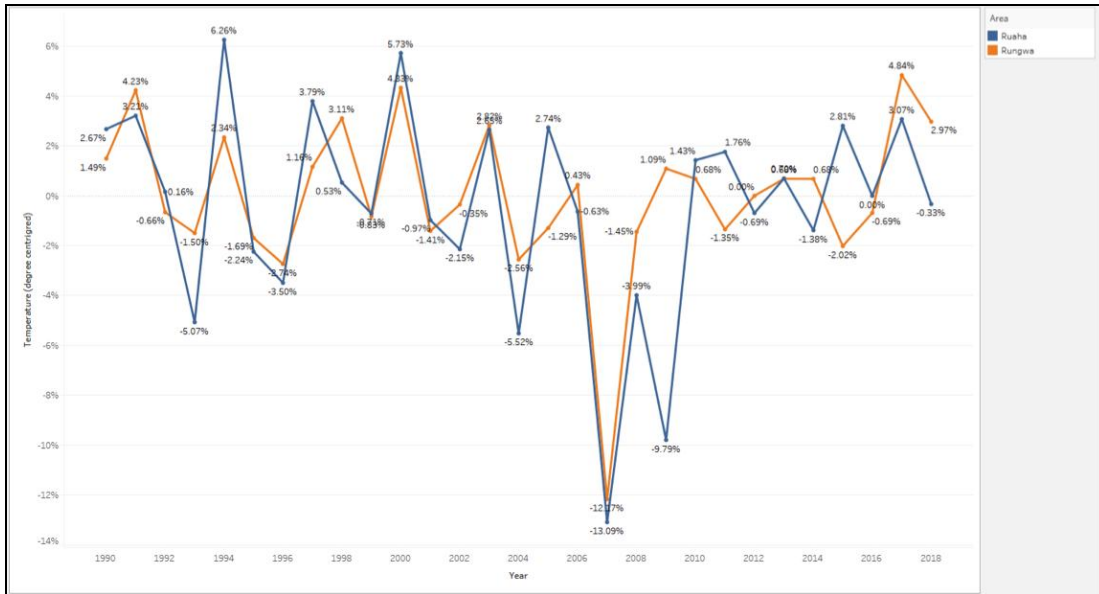


Figure 6: Percentage difference of temperature in Ruaha National Park and Rungwa Game Reserves, 1980s-2018. **Source:** Field Data Collection, (2021).

3.3 Implication of Climate Change on Tourism Development in Southern Circuit of Tanzania

3.3.1 Decreased Revenue Collection

The study found that Tanzania's Southern Circuit has a decline in tourism revenue due to climate change. Wetter months bring in low revenues than dry ones for Ruaha National Park, Rungwa, Kizigo and Muhesi Game Reserves (RKM) (Figure 7A, B & C). RKM's unpredictability in rainfall results in increased revenue during the dry months. Increased precipitation trends and extreme events in RUNAPA results in obstacles to accessibility, challenges in wildlife sighting, and early closing of accommodation facilities subsequently impeding tourism activities as well as revenue accrued.

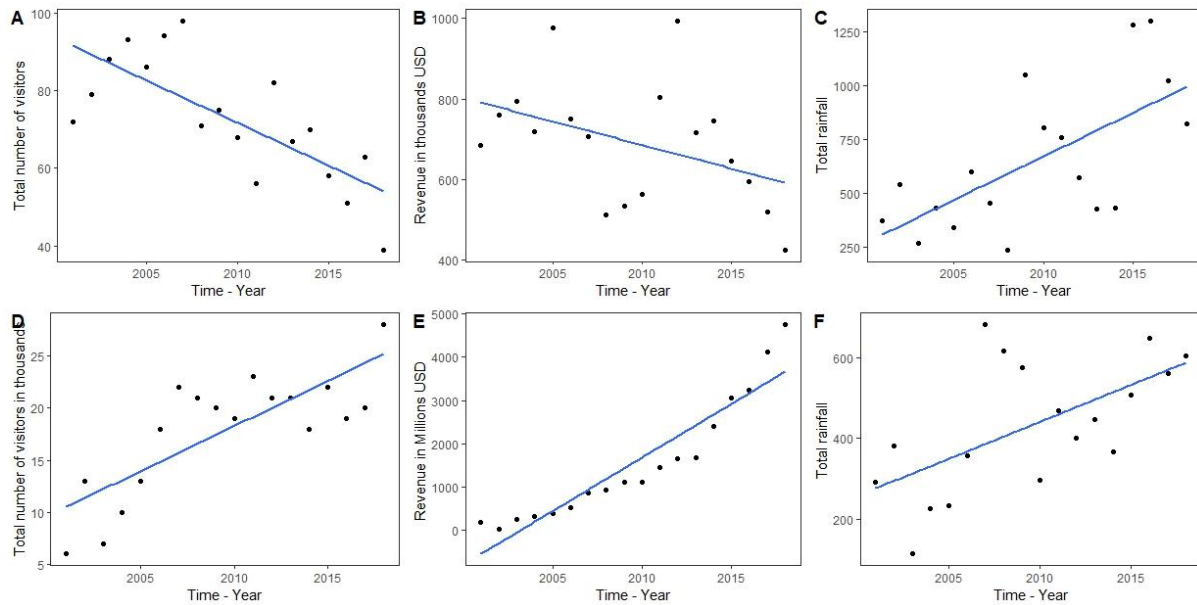


Figure 7: Trend of total number of visitors, revenues collected in relation to total rainfall received in Ruaha-Rungwa landscape for the period 2000-2018 (Figure 7A, 7B and 7C in RKM). “A” indicates total number of visitors; “B” revenue collected; “C” total rainfall (Figure 7D, 7E and 7F in RUNAPA) “D” indicates total number of visitors; “E” revenue collected; “F” indicates total rainfalls. **Source:** RKM & RUNAPA, (2020) [48& 49].

Despite periods of drought and unreliable rainfall, the study indicated that RUNAPA's revenue increased (Figure 7D, 7E & 7F). This growth was ascribed to Park Management's efforts in building infrastructure, marketing, and revenue control measures. But climate change and rising rainfall have an adverse effect on tourism attractions, resulting in fewer visitors and revenue collected [11,13].

3.3.2 Disruption of tourism seasonality

The study examined the correlation between rainfall seasonal variations and tourism seasonality in Ruaha National Park from 2001 to 2018. Results showed a significant negative but weak relationship between rainfall and tourist numbers ($r=-0.342$, $p=0.165$) while a similar correlation was found between rainfall and tourism revenue ($r=0.231$, $p=0.356$) (Figure 9D, 9E & 9F). Ruaha National Park's longer dry seasons (spanning to 8 months) offer potential for tourism development and revenue generation, benefiting both the park and local businesses reliant on tourism activities. The study reveals a weak correlation between rainfall and tourist numbers, suggesting that as rainfall decreases during the dry season, there is a slight increase in tourist activities. This could be due to better wildlife

viewing and good accessibility. Additionally, revenue from tourism activities tends to increase during drier periods.

The findings imply that park management strategies should be adjusted to optimize visitor experience during dry seasons. This includes enhancing infrastructure, improving wildlife viewing facilities, and ensuring water availability. However, sustainable tourism practices should also be emphasized to minimize negative impacts on the park's ecosystems and wildlife. Balancing economic gains and environmental conservation is crucial for the long-term sustainability of Ruaha National Park.

The study found a negative correlation between rainfall and tourism in Rungwa Game Reserve over 18 years, with increased rainfall reducing the number of tourists ($r = -0.595$, $P = 0.009$) (see Figure 10). This suggests that heavy rainfall limits wildlife attractions' accessibility, affecting infrastructure, terrain, and overall safety in the area. The reserve's accessibility is hindered by soil saturation, muddy roads, and hazardous barriers like swollen rivers and flooded crossings.

A key implication of heavy rainfall can lead to vegetation growth, causing dense vegetation cover and obstructing visibility, especially for wildlife-viewing tourists. This affects safari experiences and photographic tourism, affecting aesthetics and opportunities. Hunting tourism also faces challenges due to reduced visibility, affecting the success of expeditions. Adaptive management strategies, seasonal planning, and diversification of activities can help address these issues. Providing bird watching, educational programs, or nature-based experiences during high rainfall periods could be potential solutions, promoting sustainable tourism practices while maintaining the integrity of the natural environment.

The negative correlation between tourism and economic growth could impact local communities, necessitating diversified economic strategies. Collaborative efforts between park authorities, local communities, and the tourism industry are crucial for sustainable development. Alternative income-generating activities like agriculture and small-scale industries could provide resilience against fluctuating tourism dynamics.

Climate conditions significantly impact Ruaha-Rungwa ecosystems' tourism, with dry months attracting high tourist numbers and wetter months have low tourist numbers due to dissatisfaction. Increased rainfall and shortened dry season have impacted tourism activities in the RKM reserves.

RUNAPA's longer dry seasons and increased budgets for tourism infrastructure and promotion strategies have led to increased tourist visitation despite decreased tourist numbers due to cancellations and postponements.

The study highlights the impact of rainfall variability on Tanzania's RKM region's tourism season, highlighting increased rainfall leading to reduced revenue and early closure of tourism-related businesses. The seasonality of tourism has been affected by climate change, resulting in unpredictable times for the wildebeest migration [11]. Despite Tanzanian Hunting Regulation allowing for year-round hunting, there have been few hunting operations in RKM areas [39]. This has an effect on managing resources, especially protecting wildlife. Variations in seasonality can offer both advantages and disadvantages for outdoor leisure. For example, warmer months may attract older tourists or families with small children [40-43].

3.3.3 Destructions of infrastructure

This study observed from FGDs and interviews reveals climate-related challenges affecting tourism infrastructure in southern Tanzania PAs, including bridge destruction, river and dam overflows, settlement damage, hotel and lodge destruction, and increased inaccessibility. Heavy rains and floods damaged 10 bridges, 1 curvet, and 4 drifts during 2019/2020, destroying 20 bandas, three tented camps, and 5 ranger post houses (Figure 8). Ruaha National Park's tourism infrastructure was destroyed by increased rainfall and extreme events, despite TANAPA's efforts to allocate budgets for infrastructure development, with most bridges, drifts and culverts washed out.

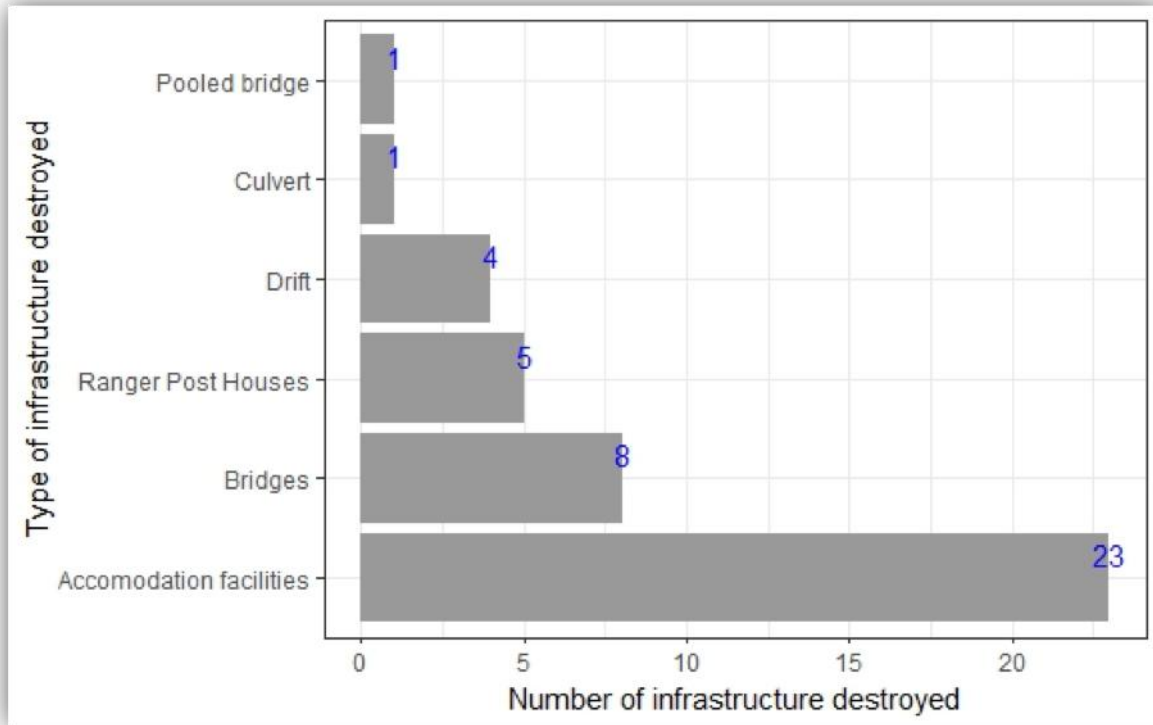


Figure 8. Damaged infrastructures due to floods in 2019/2020. **Source:** Field Data Collection, (2020).

Adjacent communities and PAs management are unaware of the influence that climate change has on tourism development, despite the obstacles they face. Although few people are aware of the direct effects of climate change and variability on tourism, the majority of respondents think these factors have no direct consequences on tourism visitation as illustrated in Table 1

Table 1: Perceived impacts of climate change on tourism expressed in percentage

Effect on tourism	Village				Total N=234
	Kitisi n = 24	Mwamagembe n = 52	Rungwa n = 76	Tungamalenga n = 82	
Tourists increased	58.3	0	0	12.2	10.3
Tourists decreased	0	0	6.6	0	2.1
No effect	0	96.2	88.2	48.8	67.1
Infrastructure destruction	16.7	0	3.9	32.9	14.5
Biodiversity decreased	25.0	3.8	1.3	6.1	6.0
Total	100	100	100	100	100

Source: Field Data Collection (2019)

The study reveals that communities primarily engaged in crop production, such as Mwamagembe (96.2%) and Rungwa (88.2%), believe climate change doesn't affect tourism activities. However, Kitisi

(16.6%) and Tungamalenga (32.9%) villages, where households participate in tourism activities, believe heavy rains and flooding events have led to low participation in tourism activities due to damaged infrastructure. The destruction of a polled bridge and major drift at Mzombe river and Makwasa area have affected tourism performance and protection operations. Road networks have also been affected, leading to inaccessibility for more than 6 months and closure of hunting activities.

Heavy rainfall in 2019-2020 negatively impacted Ruaha National Park's infrastructure, including tourism-related and administrative facilities. Major effects included the destruction of roads, bridges, and flooding of old tourist facilities. The importance of tourist infrastructure is evident as it enhances service delivery and distribution, especially in isolated destinations. The park's annual budget and operations plan show that only 1/3 of the total area has been developed for tourism activities since its gazettment in 1964. The connection between tourism development and infrastructure is crucial, as infrastructure is less resilient to severe drought and floods.

The study emphasizes the need for climate resilience in park infrastructure development to reduce environmental stress and improve tourism. Similar study recommends proactive measures like maintenance schedule adjustments, bridge height increases, and improved natural drainage systems [44].

3.3.4 Eruption of wildlife diseases and decline of wildlife population

The study reveals that diseases, such as Anthrax and Giraffe Skin Disease, are causing biodiversity loss in the Ruaha National Park. In 2016, 64 hippos died from Anthrax where the bacteria *Bacillus anthracis* was the causative agent, while 5 giraffes died from Giraffe Skin Disease [45]. In 2019, 63 wild animals died due to Anthrax, mainly along the Great Ruaha River, during the peak dry season months of February, August and September (Figure 9) [45].

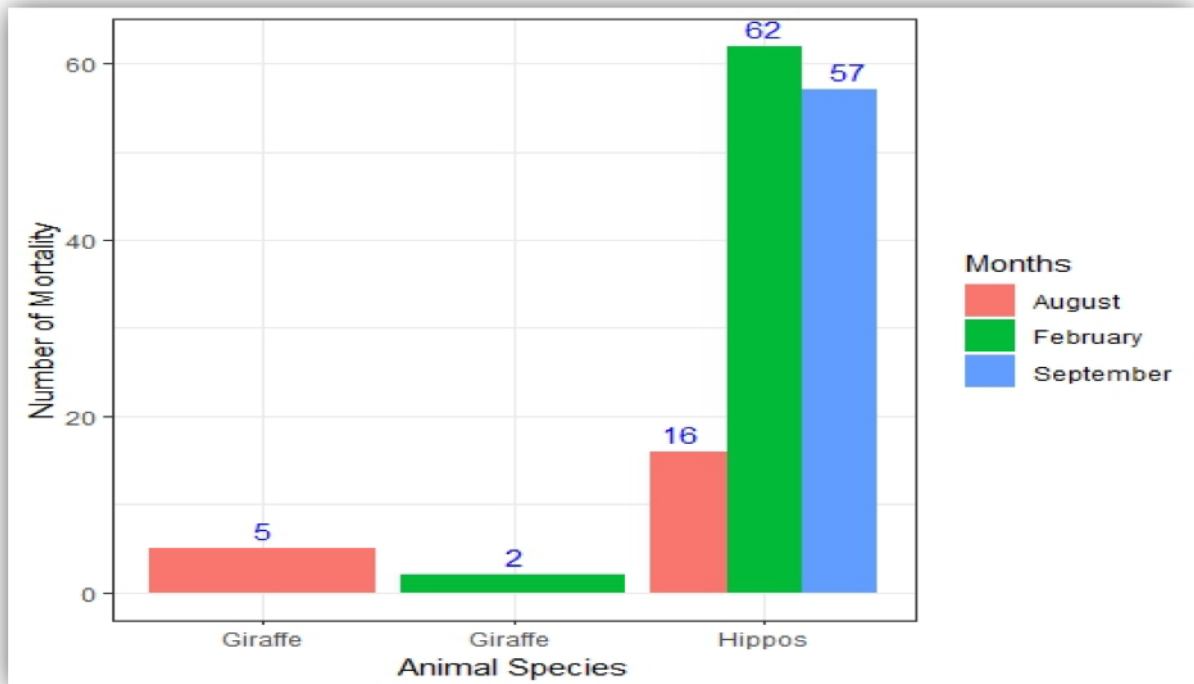


Figure 9: Wildlife Mortality from 2017 – 2020. **Source:** Ruaha Veterinary Office (2021).

Generally, this study found that rising temperatures in the Ruaha National Park have led to an outbreak of anthrax, likely due to prolonged dry periods, heavy rains, and flooding. Anthrax outbreaks are rare in both rainy and dry seasons [46]. The 2017 anthrax outbreak particularly in the month of February was likely triggered by the excessive drying of the great Ruaha River, which may have been flushed into aquatic systems like Jongomero and Nyamakifu dams. Increased irrigation agriculture, cattle grazing, and illegal fishing have also contributed to the spread of diseases and vectors, affecting wildlife.

Climate change triggers diseases outbreaks, but mechanisms are debated [47] may be facilitated by close grazing, nutritional stress, water hole congregation, and land use changes. Decreased animal species and wildlife mortality impact tourism experiences, with some activities suspended during dry seasons, including sport fishing.

4. CONCLUSION

This paper explores the impact of climate change on tourism development in Protected Areas in Southern Tanzania. It underscores the fact that tourism is a climate sensitive economic sector, with

five key activities, including cultural tourism, beekeeping, hunting, photographic tourism, and sport fishing, which all contribute to community livelihood. However, inadequate poor infrastructure, among others, hinder the effective development of tourism in southern Tanzania. The decline of wildlife populations, emergence of wildlife diseases, and early closure of tourism seasonality are significant threats to the ecological balance and sustainability of tourism development in the region. Non-climatic factors, such as budget constraints, inadequate investments, poor infrastructure, and uncompetitive position, also observed to hinder the development of tourism within the study area. The paper calls for enhanced collaboration between stakeholders, Government, and local communities to implement sustainable practices, invest in resilient infrastructure, climate adaptive plans and foster conservation efforts to safeguard tourism future and protect fragile ecosystems. Overall, the enhancement of sustainability in tourism development within the context of a changing climate in the southern Circuit of Tanzania necessitates concerted efforts from the various conservation stakeholders. The impact of climate change on tourism development underscores the need for a comprehensive and proactive approach to mitigate observed consequences. Infrastructural development must adhere to the principles of resilience, incorporating designs that factor in flooding and extreme weather conditions. Further, community support would play a pivotal role in fostering climate resilience within the tourism sector. It is therefore imperative to enhance climate awareness among local communities regarding the potential impacts of climate change on tourism development. Simultaneously, promoting community participation in diversified livelihood options so as to reduce the vulnerability to climate change-induced disruptions. Lastly, establishing connectivity with other protected areas and enhancing ecosystem conservation efforts and tourism potentials in wildlife corridors and dispersal areas are essential components of a comprehensive strategy. The synergy between protected areas and conservation initiatives would contribute to the protection of biodiversity as well as enhance the overall attractiveness of the region as a climate-smart tourism destination.

REFERENCES

1. WEF (2013). The travel & tourism competitiveness report 2013 reducing barriers to economic growth and job creation.
2. World Bank (2018). Tanzania DTIS Update 2017. 2018 International Bank for Reconstruction and Development. 1818 H Street NW, Washington DC 20433, Internet: www.worldbank.org.
3. EAC Platform, (2016). Domestic Tourism. East African Community (2000–2018). Working in East Africa.
4. Biervliet, O. V., Wisniewski, K., Daniels, J., and Vonesh, J.R. Effects of tea plantations on stream invertebrates in a global biodiversity hotspot in Africa. *Biotropica*. 2009; 41(4), 469–465. <https://doi.org/10.1111/j.1644-6429.2009.00504.x>
5. Scott, J.M., Davis, F.W., McGhie, R.G., Wright, R.G., Groves, C., and Estes, J. Nature Reserves: Do They Capture the Full Range of America's Biological Diversity? *Ecological Society of America*, 2001;11(4), 999–1006.
6. Stellmacher, T., Winter, E. and Grote, U. (2012). Protected areas in Tanzania: from ineffective management to PA certificates? In Change. Hannover, Germany: Institute for Environmental Economics and World Trade Leibniz University Hannover. Retrieved from: http://www.berlinconference.org/2012/wpcontent/uploads/2013/01/Stellmacher-et-al-2012_Protected-areas-in-Tanzania_from-ineffective-management-to-PA-certificates.pdf.
7. World Bank (2015). Environment and Natural Resources Global Practice Policy Note. Tanzania's Tourism Futures. Harnessing Natural Assets. <https://documents1.worldbank.org/curated/en/204341466992501916/pdf/96150-REVISED-PN-P150523-PUBLIC-Box393206B.pdf>. Retrieved on 31th May 2022.
8. TANAPA (2022). Strategies for promoting and developing tourism in 17 National Parks from 2022-2026. www.tanzaniaparks.go.tz
9. Davids, C. and Maliti, E. (2015). Situational analysis in support of UNDAP II. UNDP. <http://erc.undp.org/evaluation/documents/download/9342>. Accessed 12 Jan 2017.
10. Scott, D. (2006). Climate change and sustainable tourism in the 21st century. In *Tourism Research: Policy, Planning, and Prospects*; Cukier, J., Ed.; Department of Geography Publication Series, University of Waterloo: Waterloo, ON, Canada, 2006; pp. 175–248.

11. Kilungu, H., Leemans, R., Munishi, P.K.T., and Amelung, B. (2016). Climate Change management, Climate Change Adaptation in Africa. *Springer International Publishing AG* 2016 pg 365.
12. Muhanna, E. (2006). Sustainable Tourism Development and Environmental Management for Developing Countries. *Problems and Perspectives in Management*, 4(2). Retrieved from https://businessperspectives.org/images/pdf/applications/publishing/templates/article/assets/519/PPM_EN_2006_02_Muhanna.pdf.
13. Mushi, R.S. and Kangalawe, R.Y.M. (2020). Climate change impacts on coastal resources used as tourist attractions and vulnerability of coastal tourism: a case of Bagamoyo district, Tanzania. *Kivukoni Journal*, 4-7: 1-21.
14. Scott, D. and Becken, S. (2010). Adapting to climate change and climate policy: Progress, problems and potentials. *J. Sustain. Tour.* 18, 283–295. [CrossRef].
15. Kaján, E. and Saarinen, J. (2013). Tourism, climate change and adaptation: A review. *Curr. Issues Tour.* 16, 167–195.
16. Scott, D., Hall, C.M. and Gössling, S. (2015). A review of the IPCC 5th Assessment and implications for tourism sector climate resilience and decarbonisation. *J. Sustain. Tour.* 2015, 24, 8–30.
17. Simpson, M.C., Gössling, S., Scott, D., Hall, C.M. and Gladin, E. (2008). Climate Change Adaptation and Mitigation in the Tourism Sector: Frameworks, Tools and Practices. UNEP, University of Oxford, UNWTO, WMO: Paris, France.
18. Ma, S., and Kirilenko, A. (2020). Climate change and tourism in English-language newspaper publications. *J. Travel Res.* 2020, 59, 352–366. [CrossRef]
19. Van Wilgen, B.W., Reyers, B., Le Maitre, D. C., Richardson, D. M., Schonegevel, L. and Marais, C. (2016). Historical costs and extent of efforts to control invasive alien plants in the protected areas of the Cape Floristic Region and the potential for reduction. *Bothalia*, 46(2), a2043. doi:10.4102/abc.v46i2.2043.
20. Mukeka, J.M., Ogutu, J.O., Kanga, E., and Røskoft, E. (2018). Characteristics of Human-Wildlife Conflicts in Kenya: Examples of Tsavo and Maasai Mara Regions. *Environment and Natural Resources Research*. 8(3).

21. Kupika, L.O., Gandiwa, E., Nhamo, G., and Kativu, S. (2019). Local ecological knowledge on climate change and ecosystem-based adaptation strategies promote resilience in the Middle Zambezi Biosphere Reserve, Zimbabwe. *Wildlife conservation in tropical savanna ecosystem*. [https://doi.org/ 10.1155/2019/3069254](https://doi.org/10.1155/2019/3069254).
22. Coldrey, K. and Turpie, J. (2020). Potential impacts of changing climate on nature-based tourism: A case study of South Africa's national parks. *KOEDOE - African Protected Area Conservation and Science*. 62. 10.4102/koedoe.v62i1.1629.
23. Thomas, C.D., Cameron A., Green R. E., Bakkenes M., Beaumont L. J., Collingham Y. C., Hughes L. (2004). Extinction Risk from Climate Change. *Nature* 427 (6970): 145–48.
24. Hall, C.M., Amelung, B., Cohen, S., Eijgelaar, E., Gössling, S., Higham, J., Leemans, R., Peeters, P., Ram, Y., and Scott, D. (2014). On Climate Change Skepticism and Denial in Tourism. *Journal of Sustainable Tourism* 23 (1): 4–25.
25. Trawöger L. (2014). Convinced, Ambivalent or Annoyed: Tyrolean Ski Tourism Stakeholders and Their Perceptions of Climate Change. *Tourism Management* 40: 338–351
26. Buckley, R., Gretzel, U., Scott, D., Weaver, D., Becken, S., (2015). Tourism megatrends. *Tour. Recreat. Res.* 40, 59–70.
27. Sibitane, Z., Dube, K., and Lekaota, L. (2022). Global Warming and Its Implications on Nature Tourism at Phinda Private Game Reserve, South Africa. *Int. J. Environ. Res. Public Health* 19: 5487. [https:// doi.org/10.3390/ijerph19095487](https://doi.org/10.3390/ijerph19095487).
28. Creswell, J.W., and Creswell, J.D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage, Los Angeles.
29. Bergman, M. (2008). *Advances in mixed methods research theories and applications*. Thousand Oaks, CA: Sage.
30. Kothari, C. (2004). *Research methodology: Method and techniques* (2nd ed.). New Delhi: New Age Publications.
31. Leavy, P. (2017). *Research Design- Quantitative, Qualitative, Mixed Methods, Arts-Based, and Community-Based Participatory Research Approaches*. The Guilford Press, New York London.

32. Bagdonavicius, V., Dzenkeviciute, J., and Giriunas, L. (2011). Applications of Thiel-Sen slope estimator for non-parametric trend testing. *Environmental and Ecological Statistics*, 18(3), 385-399.
33. Mkonda, M. Y., He, X., and Festin, E.S. (2018). Comparing Smallholder Farmers' Perception of Climate Change with Meteorological Data: Experience from Seven Agroecological Zones of Tanzania. *Weather, Climate, and Society*, 10(3), 435–452. <https://doi.org/10.1165/WCAS-D-16-0036.1>
34. Kimaro, E.G., Mor, S.M., and Toribio, J.-A. (2018). Climate change perception and impacts on cattle production in pastoral communities of northern Tanzania. *Pastoralism: Research, Policy and Practice*, 8(1), 19. <https://doi.org/10.1186/s13560-018-0125-5>.
35. Mongi, H., Majule, A., and Lyimo, J. (2010). Vulnerability and adaptation of rain fed agriculture to climate change and variability in semi-arid Tanzania. *African Journal of Environmental Science and Technology*. 4, 371-381. 10.5897/AJEST09.207.
36. Hyandye, C. Benedict. Impacts of future climate and landuse changes on surface-groundwater balance in Usangu catchment. Diss. NM-AIST, 2019.
37. Pettengell, R., Sebban, C., Zinzani, P.L., Derigs, H.G., Kravchenko, S., Singer, J.W., Theocharous, P., Wang, L., Pavlyuk, M., Makhouloufi, K.M. and Coiffier, B. (2016). Monotherapy with pixantrone in histologically confirmed relapsed or refractory aggressive B-cell non-Hodgkin lymphoma: post-hoc analyses from a phase III trial. *Br J Haematol*, 174, 692-699. <https://doi.org/10.1111/bjh.14101>.
38. Tomalka, J., Stefan L., Felicitas, R. and Christoph, G. (2011). Climate risk profile Tanzania: Federal Ministry for economic Cooperation and Development (BMZ), Bonn.
39. Tanzania Wildlife Management Authority (2018). Ministry of Natural Resources and Tourism, United Republic of Tanzania.
40. UNWTO (2007). UNWTO Tourism Highlights, 2007 Edition.
41. Becken, S. and Hay, J.E. (2006). *Tourism and climate change: Risks and opportunities*, Channel View Publications, Clevedon. ISBN 9781845410667 329pp.
42. Scott, D., Wall, G. & McBoyle, G. (2005). The evolution of the climate change issue in the tourism sector. In Hall, C. M., & Higham, J. E. (Eds.). *Tourism, recreation, and climate change* (Vol. 22). Channel View Publications.

43. Scott, D., Jones, B., & Konopek, J. (2007). Implications of climate and environmental change for nature-based tourism in the Canadian Rocky Mountains: A case study of Waterton Lakes National Park. *Tourism Management*, 28, 570-579.
44. OECD, (2018). Climate-resilient Infrastructure, Policy Perspectives, OECD Environment Policy Paper No. 14. ISSN 2309-7841.
45. Ruaha National Park (2018). Ecological Annual Report. Ministry of Natural Resources and Tourism, Dar es Salaam, United Republic of Tanzania. www.tanzaniaparks.go.tz.
46. Stears, K., Nuñez, T.A., Muse, E.A, Benezeth, M., Mutayaba, M., and Douglas McCauley. (2019). Spatial ecology of male hippopotamus in a changing watershed. *Sci Rep* 9, 15392. <https://doi.org/10.1038/s41598-019-51845-y>.
47. Hugh-Jones, M.E., and de Vos, V. (2002). Anthrax and wildlife. *Revue scientifique et technique. International Office of Epizootics*, 21(2), 359–383. <https://doi.org/10.20506/rst.21.2.1336>.
48. Rungwa Game Reserves-RKM (2020). General Management Plans. Ministry of Natural Resources and Tourism, Dar es Salaam, United Republic of Tanzania.
49. Ruaha National Park-RUNAPA, (2020). National Park Annual report. Ministry of Natural Resources and Tourism, Dar es Salaam, United Republic of Tanzania. www.tanzaniaparks.go.tz.