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Wildlife Tourism and Climate Change: Perspectives on Maasai Mara National Reserve

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Abstract: The impact of climate change on nature-based tourism is gaining significance. This study evaluated the impacts of climate change and tourism stakeholders' perspectives on the subject in the Maasai Mara National Reserve and World Heritage Site. Surveys and interviews were used to collect data. The main climate-related threats to tourism were heavy rain, floods, and extreme droughts. These events adversely impacted infrastructure, such as roads, bridges, and accommodation facilities, and outdoor tourism activities, such as game viewing, cultural tours, birdwatching, and hot air ballooning. They also exacerbated human–wildlife conflicts. The key challenges identified in dealing with impacts were poor planning, non-prioritizing climate change as a threat, a lack of expertise, inadequate research, and a lack of internal early warning systems. The key recommendations included prioritization of climate change planning, development of internal early warning systems, and building resilience toward climate-related disasters. This study contributes to practice by making recommendations for management and other stakeholders. It also extends the discussions of climate change and tourism to wildlife tourism destinations in Africa.

Keywords: climate change; extreme rainfall; nature tourism; climate change adaptation; human-wildlife conflict; SDGs; conservation; World Heritage Site

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1. Introduction

Tourism and climate are inextricably linked to each other. In many respects, the climate shapes several tourist activities [1]. Consequently, climate is a resource and an enabler of tourism in many ways. Tourism is a significant carbon emission source that contributes to climate change [2,3]. Many tourism activities, including game viewing, beachgoing, sightseeing, hiking, skiing, and mountaineering, are climate-sensitive because they require certain ideal weather conditions to take place [4–6]. Therefore, climate change inevitably affects tourism enterprises.

Recent studies have pointed to the deep vulnerabilities of nature-based tourism destinations, particularly in relation to extreme weather and climate change events [7–9]. This vulnerability is particularly evident in African nature-based tourism destinations [10,11]. Some of the major climatic threats to African tourism include increasing temperatures, floods, severe droughts, snow melt, frequency of tropical storms, sea levels, and coral bleaching degrees [12].

Geographical gaps exist in research focused on climate change in the context of tourism in the global south, including African countries [13–15]. Ironically, most countries that depend on tourism as a significant contributor to their national economies are also vulnerable to climate change [16,17]. There is generally a scarcity of studies focusing on climate change in some African tourism destinations, including those in East Africa [18,19]. While some African studies have demonstrated the vulnerability, impact, adaptation, and mitigation characteristics of wildlife tourism in relation to climate change [8,20–23], most have focused mainly on Southern Africa. All other African regions have been scantly

covered concerning tourism and climate change; this includes studies focusing on East Africa [9,18,24–26], which lacks stakeholder perspectives on wildlife tourism destinations.

Kenya is well known for its wildlife tourism, which accounts for 70% of its tourism earnings and is mainly concentrated in 23 terrestrial national parks and 28 reserves. In addition, the country has four marine parks, six marine reserves, and private and community conservancies that are beyond the scope of this study. According to Kenya's National Tourism Blueprint 2030, wildlife tourism, commonly dubbed "the African safari", is the country's leading core tourism product. Despite the significance and vulnerability of wildlife tourism, there is a scarcity of studies on climate change and wildlife tourism in the Kenyan context.

This study attempts to close this gap. Therefore, this study examines key industry stakeholders' views on climate change threats, impacts, and challenges in the Maasai Mara National Reserve, a famous wildlife tourism destination in Kenya. Tourism stakeholders can be viewed from the perspectives of demand (tourists) and supply (businesses, employees, host communities, governments, and environmental groups) [27,28]. This study focuses on the supply stakeholders who provide tourism products and create an enabling environment for tourism. This paper comprises six sections: introduction, literature review, methodology, findings, discussion, and conclusion.

2. Literature Survey

Wildlife tourism involves observing and interacting with local animals and plants in their natural habitat [29]. In Africa, this phenomenon occurs mainly in protected terrestrial and marine areas. Protected areas and, by extension, wildlife tourism destinations are vulnerable to climate change [9,11,23,30]. As documented in the extant literature, the negative impacts of climate change threats on protected areas in parts of Africa have various implications for tourism. Increased temperatures have increased vector-borne, food-borne, and water-borne diseases [31]. Some destinations face aviation challenges due to extreme heat, especially during landing and takeoff [32]. These challenges sometimes result in cancelled trips and changes in travel patterns [1].

In addition to rising temperatures, variations in precipitation due to climate change are also a threat, with tourism destinations receiving too much or too little precipitation [33]. In the former scenario, flooding and erosion is a challenge in some destinations, such as Kruger National Park in South Africa [34]. At the same time, droughts have increased aridity, desertification, wildfires, water shortages, and food insecurity in destinations such as Serengeti in Tanzania [9,35–37].

In addition, hailstorms, landslides, and cyclones pose a security risk to tourists and destroy tourism infrastructure [38,39]. Mushawemhuka et al. [10] posited that tourists and tour operators in nature-based tourist destinations in Zimbabwe have identified temperature increases, reductions in precipitation, and weather hazards as critical concerns for tourism. Mkiramweni et al. [23] identified water shortages, vegetation changes, biodiversity losses, and recurrent livestock and human diseases as the main effects of climate change on wildlife tourism in protected areas.

Extreme weather events such as droughts, floods, and extreme heat in Kruger National Park have led to the loss of flora, fauna, and infrastructure that support tourism and disrupt tourist activities [12]. Drought also disrupts wildlife migration and tourist flow patterns [40]. For instance, the famous annual wildebeest migration between Serengeti and Maasai Mara has been affected by the delayed onset of rain, resulting in losses for tour operators who had pre-booked clients [9].

Droughts also contribute to competition for natural resources, such as water and pastures, especially in arid and semi-arid areas such as the Maasai Mara National Reserve (MMNR). Jolly et al. [41] reported reduced animal populations owing to climate change-induced droughts and wildfires in protected areas. Ultimately, in the long run, it is feared that these threats will reduce tourist destinations' appeal, alter seasonality, and decrease

tourism flow [42]. Despite these concerns, studies on the impacts of climate change on tourism in the Maasai Mara National Reserve are scarce.

Studies project that low- and middle-income countries face significant tourism losses from climate change damage [43]. Chikodzi et al. [44] bemoaned losses and damage to culture and heritage in protected areas due to climate change in South Africa. Dube and Chikodzi [45] bemoaned the losses of beaches and other tourism assets due to rising sea levels triggered by climate change along South Africa's coastline, causing severe challenges for park management and tourists alike.

Dealing with climate change from a tourism perspective has been challenging owing to various challenges, wide knowledge gaps, lack of technical capacity [2] and, in some instances, poor governance framework. Additionally, participatory governance and climate change policy integration into tourism management are lacking [46]. Where policies exist, there are implementation challenges [47]. This is especially true in the African context, which often juggles varying priorities given its historical and socio-economic context.

Climate change comes with adaptation and mitigation costs for industry. Investments in resilient infrastructure and other adaptive measures increase operational costs for tourism [48]. In some instances, rolling out capital projects for adaptation or mitigation is beyond the capacity of tourism business enterprises. This increases the industry's vulnerability, especially for small- and medium-sized enterprises and the host communities whose livelihoods depend on tourism. Furthermore, promoting responsible travel may be challenging as tourists opt for convenience and price at the expense of sustainability [49].

Tourism destinations also have to deal with shifts in demand and the loss of the resultant livelihoods occasioned by climatic changes [50]. Whilst some destinations may have to deal with over-tourism as they benefit from favorable weather changes, others may lose tourists due to the adverse impacts of climate change. Managing these changing patterns introduces new dynamics that pose challenges to destinations.

Climate change in these countries remains under-researched [48]. This implies a paucity of context-specific research and data to support destination-specific policy formulation [51]. Thus, in response to the knowledge gaps, this study seeks to answer the following key research questions: (i) "What is the evidence of climate change in Maasai Mara National Park?" and (ii) "What are climate change's observed and perceived impacts of climate change on the Maasai Mara National Reserve from a tourism perspective?".

3. Materials and Methods

3.1. Study Area

Maasai Mara National Reserve (MMNR) is Kenya's leading wildlife tourism destination. It is located in Narok County, which is in the southwestern part of Kenya (Figure 1), and covers an area of 1510 km^2 [52]. It was proclaimed as a UNESCO World Heritage Site in 2023. It forms the northernmost part of the Mara–Serengeti ecosystem, the world's largest ecosystem, which hosts the last surviving multispecies migration on the planet. Migration consists of more than 1.5 million wildebeest, zebras, and antelopes, and it attracts various predators, including lions, hyenas, cheetahs, and leopards. This annual spectacular event has been dubbed the eighth wonder of the modern world and is a popular tourist attraction. MMNR comprises the Mara Triangle, which the Mara Conservancy manages, and Central Mara (also known as the greater Mara), which the County Government of Narok manages [53]. The Mara River Bridge, a popular site for spectacular annual wildebeest migration, interconnects the two. This iconic UNESCO World Heritage Site that shares its border with Serengeti National Park of Tanzania lies at an altitude of 480–2280 m above sea level, which can influence the area's climatic weather pattern. Maasai Mara receives rainfall throughout the year, with two punctuated episodes of high rainfall peaks between November and December and from March to May. Times of extremely high rainfall episodes can affect certain tourism activities due to access issues given the gravel roads. During seasonal droughts, animals also tend to be concentrated in areas with a perennial supply of rainfall, which can shape tourism's game viewing opportunities. The Maasai Mara Game Reserve

shares its borders with the Indigenous Maasai People of Kenya. The Maasai people are traditionally nomadic. This group of people is found on the Kenyan and Tanzanian sides of the border, as the game reserve is just on the border between the two countries.

Figure 1. Map location of Maasai Mara Game Reserve.

3.2. Theoretical Framework

The study relied on the Vulnerability Framework as a guiding framework. The framework emanates from the fact that climate change is a reality that results in socio-environmental and ecological risks [54]. Given diverse environmental factors, the framework also acknowledges that areas' vulnerabilities differ from one geographic area to another. This approach underscores the need to conduct vulnerability assessment as an imperative for policy response and infrastructure planning. The Vulnerability Framework attests to the need to make management plans to respond to climate change-induced disasters. The Vulnerability Framework allows researchers to look at climate change exposure levels, potential impacts, residual vulnerabilities, and sensitivity analyses and call for exploring adaptive and mitigation options. The framework is generally accepted in climate change studies and has been used for some time within the research field [55,56].

Ayanlade et al. [57] argue that the Vulnerability Framework, which allows for transdisciplinary research, allows for an understanding of vulnerabilities to reduce risk and ensure that entities can make informed decisions to safeguard societies from maladaptation and ensure resilient development. In this study, the framework allowed for an understanding of key vulnerabilities faced by the Maasai Mara National Game Reserve and to identify potential adaptation measures that can be adopted to ensure climate change resilience.

3.3. Data Collection Procedure

This study adopted a mixed-method case study design used in several other climate change and tourism studies [44,53,58,59]. Case studies enable an in-depth examination of a research area [60]; hence, they were suitable for this study, which focused on climatic issues unique to the MMNR. Primary data were collected through questionnaires and interviews with key informants. Field observations and secondary data from relevant reports and documents in the public domain supplemented these data. Rainfall satellite data from 1981 to 2022 were also analyzed using the Mann–Kendal trend analysis. A multi-method approach was utilized to triangulate the findings to increase the reliability of the study's findings [61,62]. Climate data in this regard were used to verify human observations from interview-generated data, questionnaire-generated data, and data collected from field observations.

A total of 83 questionnaires were administered to game rangers, tour guides, tour drivers, and hoteliers using a convenient and random sampling technique in and around the reserve in 2024. The questionnaire for the survey was mainly close ended, with a few open-ended questions. It contained questions on observed climate change trends, threats, and impacts of climate change in the park. The tool also explored the challenges emerging from climate change threats and impacts. The questionnaires were conducted using the QuestionPro Offline App and were self-administered to increase the response rate. QuestionPro also allowed for the instantaneous analysis of responses with qualitative and quantitative data analysis capabilities. To this end, 92 people were invited to participate in the questionnaire, and only 83 completed the survey.

The participants were between 18 and 60 years old. The respondents' educational backgrounds were broken down as follows: primary education (6%), secondary education (29%), diploma (44%), degree (20%), and post-degree (1%). This means the respondent group had a modest education level and the capability to tackle some of the critical climate change questions, as indicated in Figure 2. Broadly speaking, most respondents were tour guides or game rangers, comprising 70% of the population.

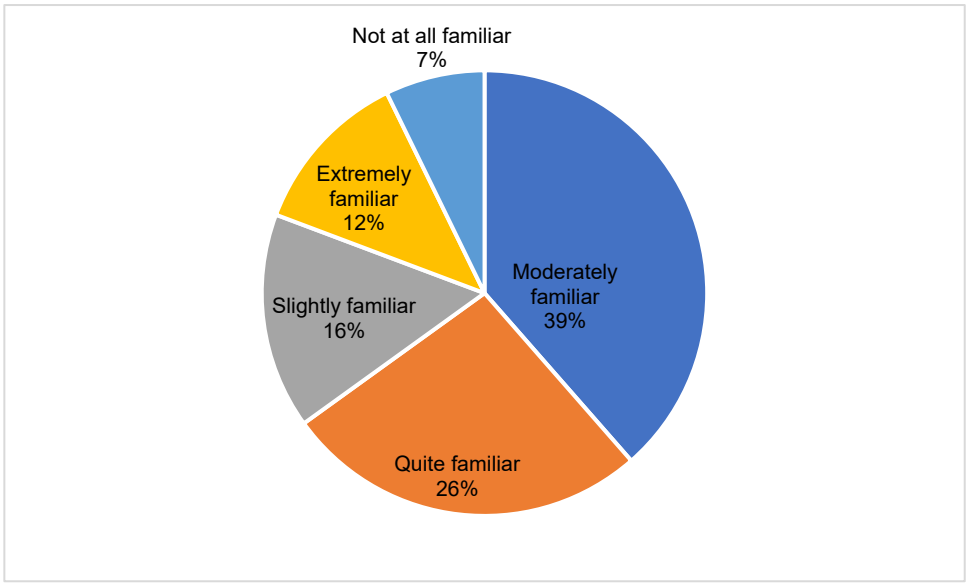

Figure 2. Stakeholders' familiarity with climate change: data from questionnaire survey.

In addition, four interviews were conducted in 2024 with key informants purposely selected from the management of conservancies and the Mara central sections of the MMNR. The interviewees comprised two park wardens and two conservancy managers. These were selected owing to their positions and roles in the management of MMNR, which made them privy to information on the impacts of climate change on tourism, interventions in place, and implementation challenges. An interview guide was used to collect the

data. The tool contained questions on observed climate change trends, the impacts of climatic change, what has been done to enhance climate change action in the park, and the challenges in dealing with these impacts. Interviews were recorded with permission from the respondents for later analysis. A note-taking process supported this process. Themes similar to those used in the questionnaire were used. Probing was conducted to ensure that the responses covered all critical aspects being pursued.

Climate data were obtained from the Prediction of Worldwide Energy Resources (POWER). This platform provides meteorological data from NASA projects for renewable energy, building energy efficiency, and agricultural purposes. The meteorological data were archived from NASA's Global Modelling and Assimilation Office Modern-Era Retrospective Analysis for Research and Applications-MERRA-2 assimilation model and GEOS-5.12.4 FP-IT, in which the data date back to the 1st of January 1981. The data used were based on the monthly and annual POWER data version of 2024 in August, which has improved capacity for data traceability. MERRA-2 data has been used to understand climate scenarios in Sub-Saharan Africa [63] and East and Western Africa [64].

3.4. Data Analysis

Data from POWER have been used in previous studies [65,66], and the website tool has several functionalities, including conducting basic statistical analysis and map visualization data. A time series climate data analysis was conducted using the NASA Prediction of Worldwide Energy Resources (POWER) | Data Access Viewer (DAV) v2.3.6 inbuilt analysis tool. The Esri mapping tool can produce time series graphs and map visualizations. The data were obtained from the Maasai Mara National Game Reserve using the point data tool. Additional data analysis was conducted using the Julius tool to conduct a trend test for the climate data. Julius AI, like other data analytical tools, relies on machine learning algorithms to conduct complex statistical computations and can handle, process, and visualize large datasets, such as daily meteorological variable datasets, and visualize outputs in the form of graphs or maps.

Similarly, data from QuestionPro were analyzed using QuestioPro's built-in statistical capabilities, and simple descriptive statistics were used for this study. Data from the interviews were analyzed thematically. The data were transcribed sequentially, and the responses were reduced to a written report. Codes and themes were then developed, paving the way for report writing. The research questions informed the analysis and code generation, with climate change threats, impacts, and challenges being themes that emerged from this process.

4. Results

The results section is divided into two sections. The first section deals with evidence of climate change based on archival data and data from fieldwork observations. The second section deals with perceived climate-related threats and their impacts on tourism.

4.1. Evidence of Climate Change in the Maasai Mara National Game Reserve

This study analyzed rainfall data for the period 1981–2022. It was found that Maasai Mara received an average of 901.08 mm a year. This large amount of rainfall posed several challenges to the game reserve. The trend showed that the average total rainfall increased over time. However, this increase was not statistically significant (Figure 3). This was in contrast to other parts of Africa, where there were concerns about a general decline in the annual average rainfall in protected areas [67]. There was evidence of extremely high rainfall events in some years and not in others. The year 2020 was one of the wettest years on record.

Monthly data analysis also revealed that rainfall patterns varied monthly (Figures 4 and 5). On average, there were slight declines in the rainfall in February and May. This could indicate seasonal pattern changes during these months.

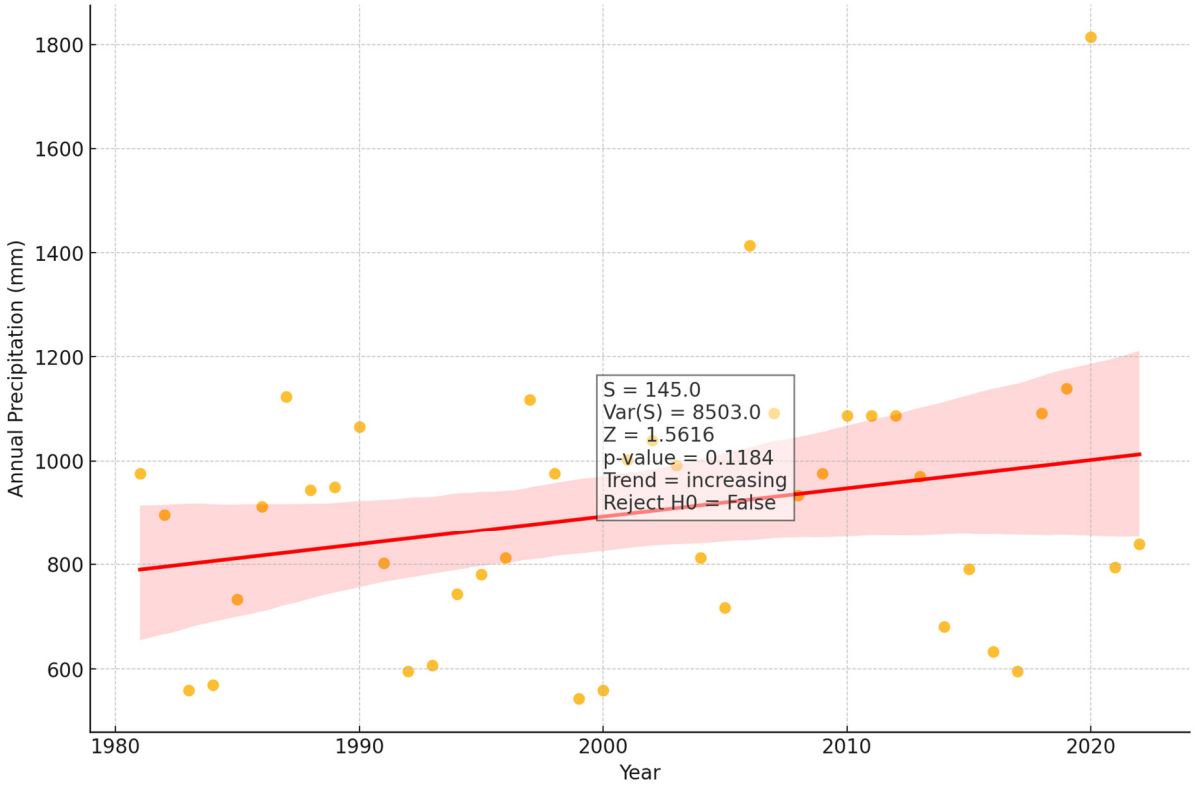

Figure 3. Rainfall trend for Maasai Mara between 1981 and 2022.

All the other months, however, showed increases in rainfall in all the other months. The increase in rainfall posed varying benefits for tourism enterprises in the Maasai Mara National Reserve. An increase in rainfall could positively affect the growth of the grass stratum, which could translate into improved animal conditions. This would also improve community relations due to reduced drought-induced human-wildlife conflicts.

Nonetheless, the increase in vegetation stratum can be problematic, as lash vegetation, including grass, can inhibit game viewing [33]. Field observations revealed that this savannah biome had several tall grass areas that adversely affected game viewing. In addition, grass growth could favour building a significant amount of fuel, increasing the risk of wildfires.

The increase in rainfall (particularly daily rainfall, as shown in Figure 5) was equally a challenge for the game reserve on many fronts, including its effect on infrastructure. The Maasai Mara National Reserve used dust roads, and with each downpour, there was a wide washing away of gravel roads, which posed challenges for traffic movement across the park. Large amounts of gravel were washed away annually, and field observations noted that the road was constantly being repaired, which is something that reserve officials confirmed. Washing away cost the reserve a substantial amount of money annually, which was a loss as rainfall occurred almost all the year. Some roads and sections of the park exhibited high levels of erosion. This problem was further compounded by increasing rainfall in the area. Some roads could be rendered impassible, especially after prolonged or heavy rainfall due to localised flooding and road damage, which facilitated the formation of gullies.

In 2024, severe rainfall led to flooded rivers breaking their banks in the park. This led to the destruction of bridges in the park, including the Mara Bridge and the newly constructed Talek River Bridge. Consequently, tented camps (a common feature of Maasai Mara) in low-lying areas were flooded and swept away. This necessitated the evacuation of tourists and the closure of camps for an extended period, disrupting tourism activities.

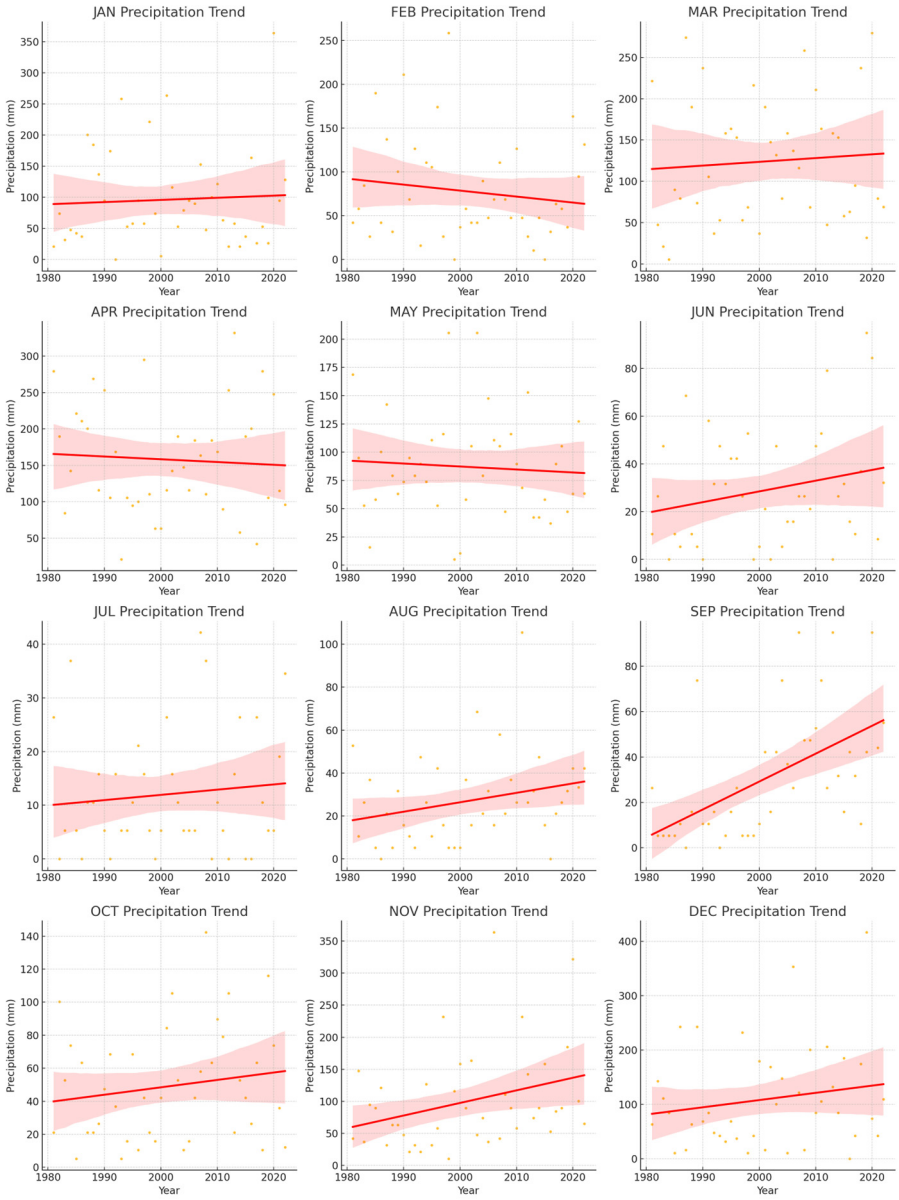

Figure 4. Monthly rainfall pattern for the Maasai Mara Nature Reserve in 1981–2020.

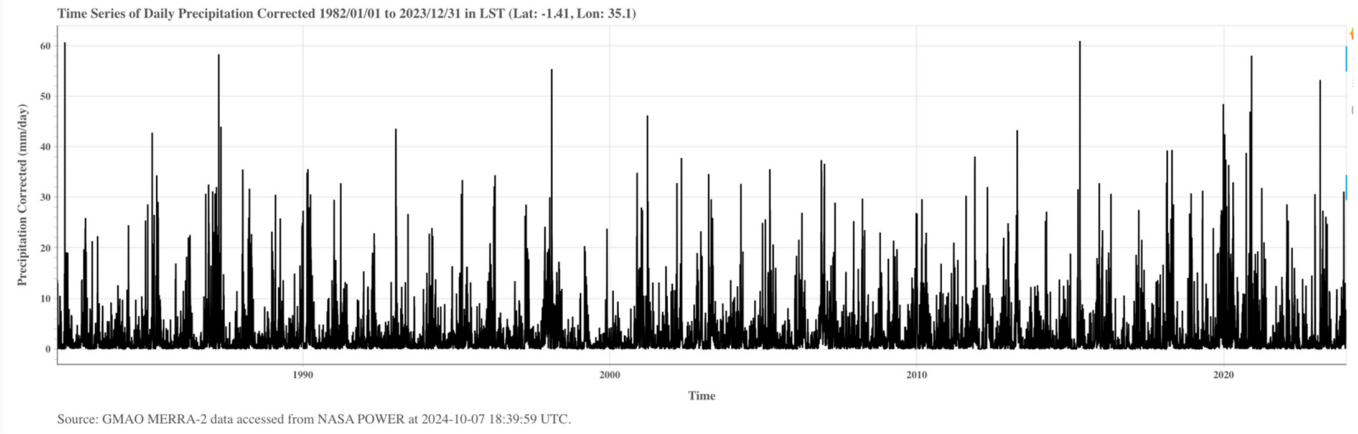

Figure 5. Time series analysis of daily precipitation for Maasai Mara corrected from 1982 to 2023.

Heavy rain and flooding, therefore, resulted in economic and non-economic losses for tourism in the MMNR. These included significant financial losses, property losses, and safety risks for tourists and other stakeholders. These processes also resulted in cancellations by some tourists, resulting in greater losses for business stakeholders. These findings concurred with similar studies on the impacts of weather events on tourism destinations by Kifworo et al. [39] and Wu et al. [50].

Regardless of increased rainfall activities, there was evidence of years of drought, which is of equal concern. There were several years in which rainfall fell below the average expected rainfall value. Attention must be paid to understanding how such droughts affected the ecologies of the game reserves.

Where temperature is concerned, the study found that the temperature for the reserve remained largely constant over time. However, there was a slight increase in temperature over time, which was consistent with global warming. Figure 6 shows a couple of days where temperatures breached 35 °C, with most of these days being concentrated around and after 2000. It is important to note that the highest daily temperature was recorded post-2015, which agrees with the increasing temperature narrative.

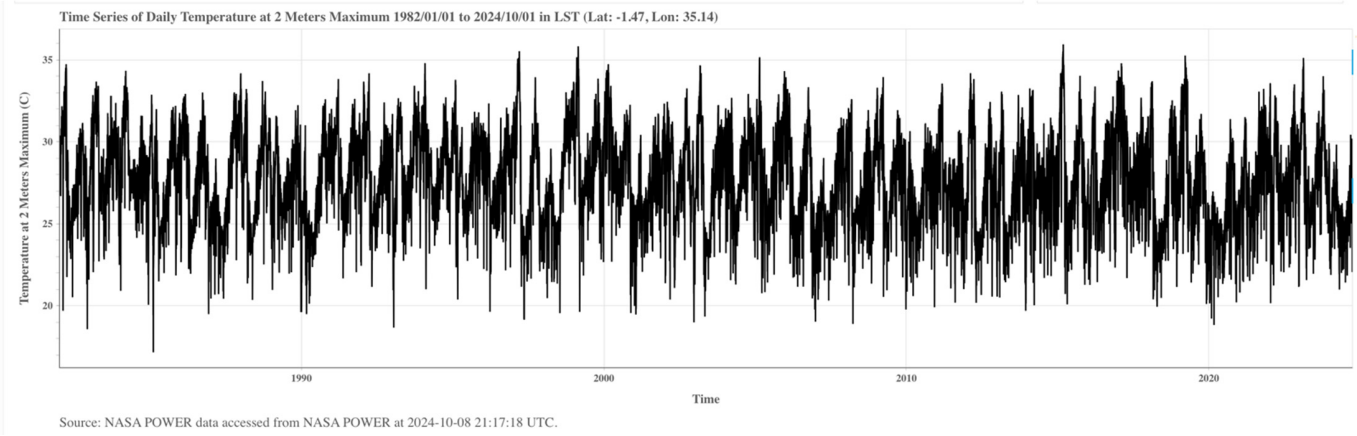

Figure 6. Time series analysis of daily temperature for Maasai Mara corrected in the period of 1982–2023.

Interviewees with key informants at the reserve indicated that the stakeholders were worried about the increased occurrence of "heat wave days in and around the reserve as it can result in some deep discomfort for employees and tourists". Given that most of the accommodation establishments were in the form of safari tents with no infrastructure for air conditioning, this is a major concern that could require long-term planning and action on the part of hoteliers. Slight but noticeable temperatures were witnessed in February, July, August, September, and October. Increased temperature also raised fears of the increased occurrence of fires, which could damage the rich Maasai Mara biodiversity. Given the high rainfall and fuel load, increased temperatures could increase the fire intensity and damage the ecosystem.

4.2. Perceived Climate-Related Threats and Their Impacts on Tourism in Maasai Mara

4.2.1. Perceived Climate-Related Threats in Maasai Mara

Evidence from climate data was triangulated with interview data, field observations, and questionnaires. Tourism stakeholders identified several vulnerabilities to tourism in the national reserve, including extreme drought, heavy rainfall, floods, and extreme heat waves (Figure 7). Drought stood out as one of the most significant threats to the game reserve, given its potential to upset biodiversity, followed by heavy rainfall and flooding, given their potential to disrupt tourism activities and infrastructure in the reserve. A combination of extreme rainfall and flooding was the biggest threat to the reserve, followed by extreme droughts. As much as climate data showed that drought sometimes occurred,

most areas still received substantial rainfall almost every year. The stakeholders believed that the drought they sometimes witnessed in Maasai Mara was a sign of climate change.

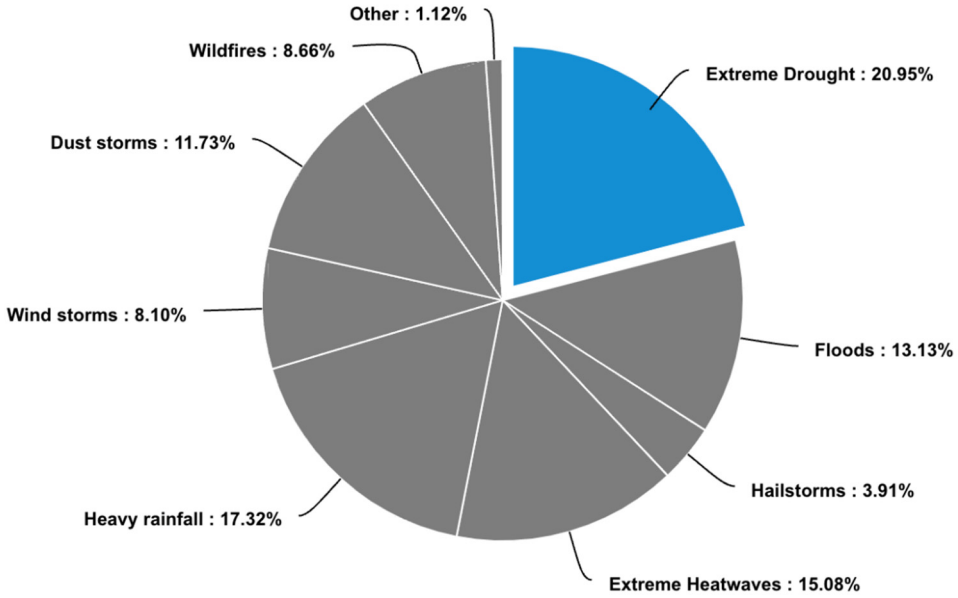

Figure 7. Potential risks of Maasai Mara to various extreme weather events: data from questionnaire surveys.

In light of observations on the impact of intense rainfall in the game, the survey respondents equally observed hydrometeorological events of this nature that were particularly damaging to road infrastructure (Figure 8). Intense rainfall was also flagged as the game reserve's leading cause of loss and damage to roads, communication infrastructure, and electricity supply and one of the leading causes of soil loss due to erosion. Given that the roads in the game reserve were out of gravel, they were often washed away after floods. Moreover, intense rainfall activity also disrupted the power supply and communication network in and between the reserve. Given that the accommodation infrastructure comprised semi-permanent structures in the form of tents, these structures were highly susceptible to damage during intense rainfall activity that often occurred in the area, as seen from earlier presentations of climate data. This was confirmed through field observations. Building infrastructure that could withstand the harsh realities of the Maasai Mara is critical. There is a need to revise infrastructure-building codes to consider extreme weather events to ensure climate adaptation and resistance. This would minimize the associated losses from hydrometeorological events, such as intense rainfall activity, which is increasingly common in that area.

Droughts were highlighted as a challenge to water supply in the park. This is particularly so given that during interviews, it emerged that droughts reduced watering points. This resulted in animals travelling greater distances to find water. Droughts also threatened the viability of wetlands in the reserve, which could upset biodiversity as wetlands are considered hubs of biodiversity. Heatwaves and fire were other key challenges noted by the study for accommodation as they could damage infrastructure and other such property in the reserve.

The study further revealed that extreme drought disrupted the water supply, in addition to heavy rains and floods, resulting in dried watering points, which affected wildlife (as presented in Figure 8). In addition, interview responses indicated that reduced water levels caused by drought led to injuries and even death due to territorial fights among the hippos. Consequently, droughts also increased the pressure at a few watering points and greatly increased the travelling distance for animals to perennial water sources, possibly leading to animal disease outbreaks. This could be problematic given the densities

of animals in the Maasai Mara Game Reserve and Serengeti National Park, which is part of the safari area. There were fears and uncertainties regarding how hydrometeorological events such as these could affect animal migration between the two places of Maasai Mara on the Kenyan Side and Serengeti National Park on the Tanzanian side. Extreme heat also damaged the delicate skin of the hippos, resulting in fatal injuries. These resulted in a reduced wildlife population, as posited by Pellegrini et al. [68].

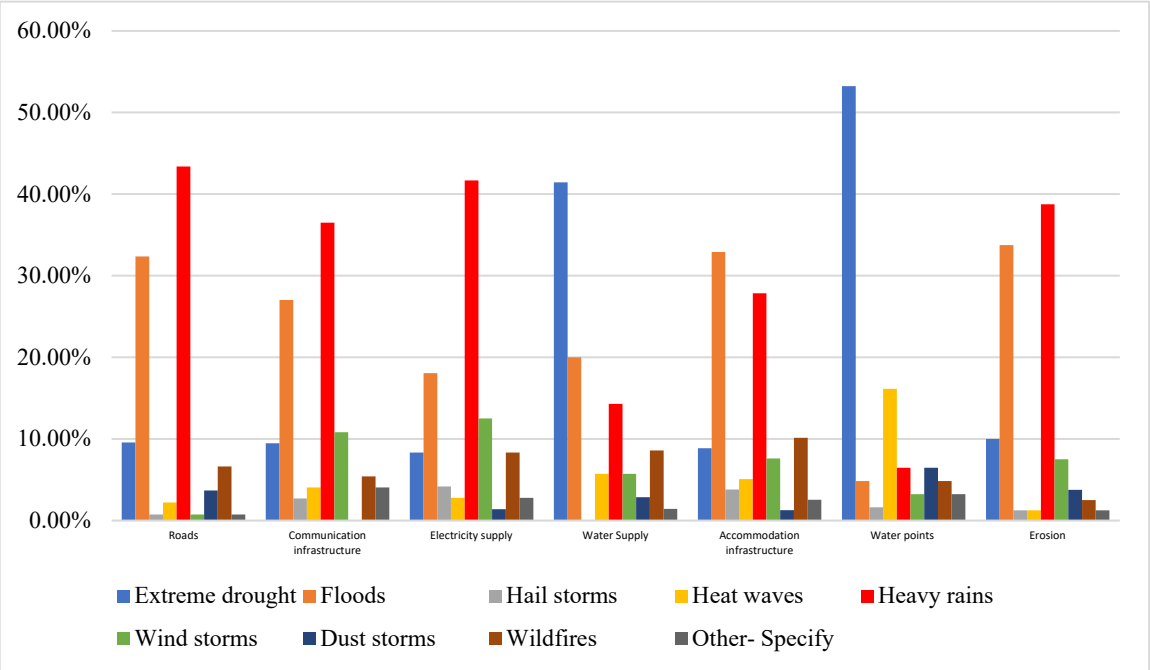

Figure 8. Infrastructure damage by extreme weather events: data from questionnaire surveys.

4.2.2. Impact of Hydrometeorological Events on Tourist Activities

Maasai Mara is one of Kenya's most visited game reserves. Visiting patterns were closely linked to the weather and associated tourism activities. The great wildebeest migration, which involved the cyclical movement of various animals, could become millions between Maasai Mara and Serengeti. This event was one of the events that was sought after by tourists in that region, often resulting in mass tourism and the overpopulation of these two safari areas. A question was posed as to how climatic events could shape tourism activities and experiences in the Maasai Mara National Game Reserve. The study revealed that heavy rains and floods adversely affected outdoor tourism activities (Figure 9). Rainfall was not conducive for outdoor activities and could dampen the safari experience. This could be attributed to several factors, and most gravelly roads were impassible during such events. This notion was confirmed by key informants who noted that "a substantial amount of money was being spent on roads". This resulted in revenue losses for lodges, tour guides, and safari operators who cash on events.

Conversely, respondents who equally cited poor animal sightings reported poorer sightings on rainy days. Ordinarily, animals are less mobile on such occasions on land than in water; water is a great trigger for animal movement that is easily available without moving distance. The findings also revealed that heavy rains mostly affected cultural tours and activities, which curtailed access to nearby villages. Other affected activities included birdwatching, hot air ballooning, bush dinners/breakfasts, sundowning, and nature walking.

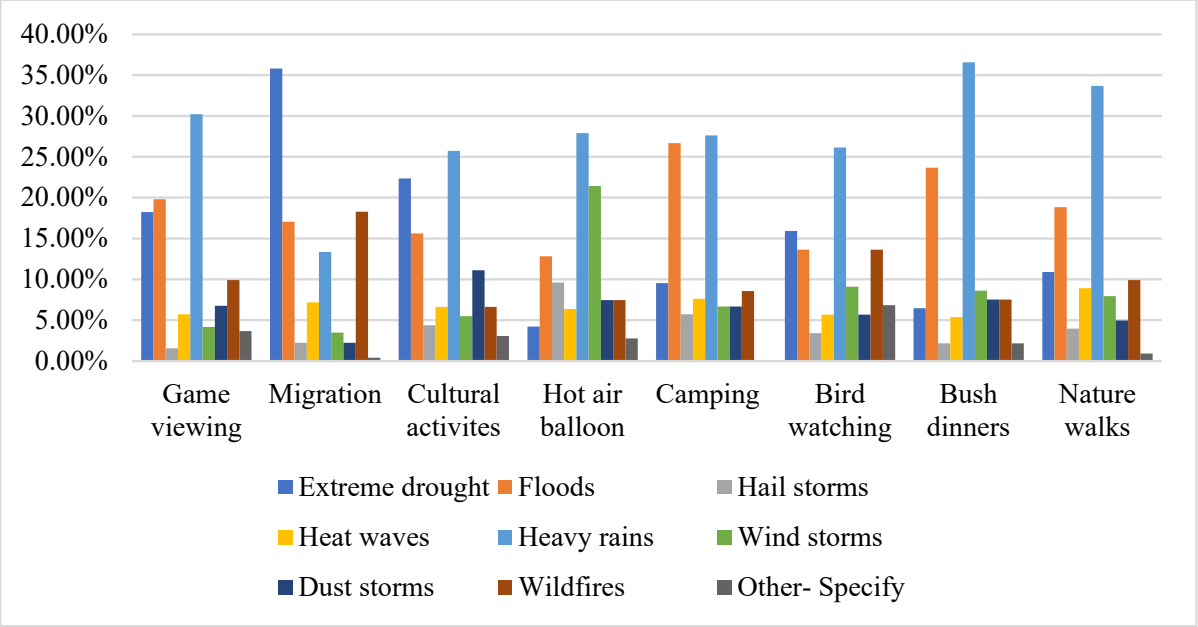

Figure 9. Activities interrupted by extreme weather events: data from questionnaire surveys.

Heavy rain also affected activities such as bush dinners, which are a favorite for tourists. Rainy conditions harmed one of the largest and most expensive tourist activities in the National Game Reserve: hot air ballooning. This activity would allow tourists to enjoy a safari experience from the air. Hot air ballooning was equally affected by high winds, which were reported to have increased by a few groups of respondents in this survey. There were also concerns about fire disruptions in hot air balloons.

Tourist activities in the MMNR were affected by extreme weather events other than heavy rains and floods, as indicated in Figure 8. Wildebeest and other species migration, representing the signature brand activity for the MMGR, was affected by extreme drought followed by wildfires. This sometimes resulted in a delay in the annual wildlife crossing the Mara River, which was the main pull factor for tourists visiting MMNR from July to September. Since most migration-based packages were pre-booked, delays in the actual crossing prevented guests from seeing the iconic scene, leaving them unsatisfied. These impacts on tourist activities were similar to the findings of Coldrey and Turpie [69]. The findings also revealed that cultural tours and activities were affected by extreme drought, which caused pastoral communities to migrate in search of water and pastures for their animals. Hot air ballooning was most affected by windstorms.

4.2.3. Impact of Climate Change and Human-Wildlife Conflict

In addition to the environmental impacts, the study revealed some socio-economic impacts of extreme weather events, as shown in Figure 10. The leading effect was increased incidents of human–wildlife conflicts. The interviews revealed that lions, elephants, and buffalo were the main perpetrators of these conflicts. These findings were consistent with those of Abrahms et al. [70]. Tourist complaints about the deteriorating experience of the MMNR, human encroachment into the protected area, and tourist cancellations followed. In descending order, other impacts included staff complaints about the impacts of extreme events, safety concerns, and bad publicity.

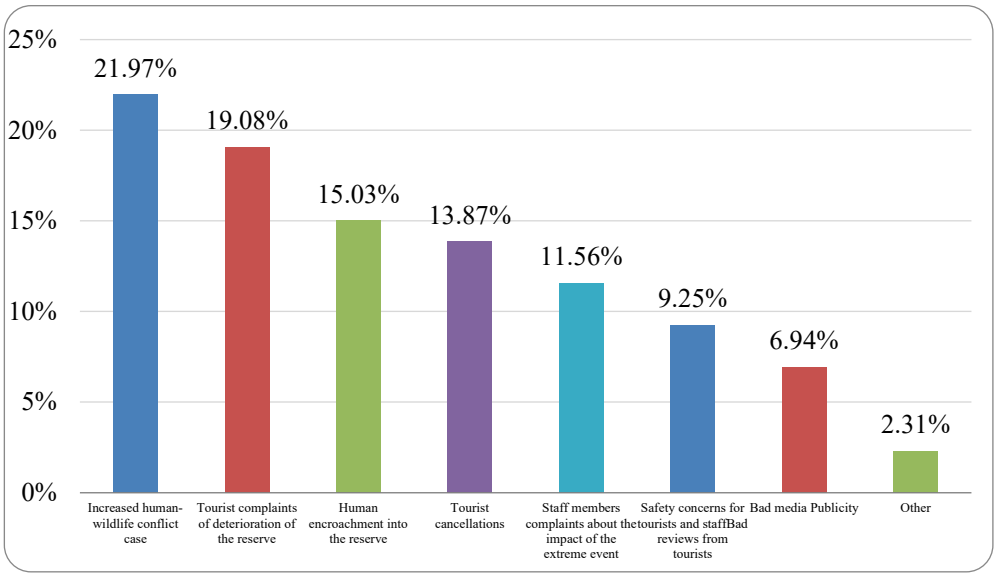

Figure 10. Socio-economic impacts of extreme weather events.

5. Discussion

Unlike in other parts of Africa where protected areas are battling the decline in annual total rainfall due to increased drought and aridity, such as Kruger National Park [68], Maasai Mara is generally battling the increased annual rainfall level. As much as droughts do occur, the area still receives significant amounts of rainfall in those areas, which is adequate to support the game reserve's savannah ecosystem. Such a development presents challenges that manifest in damaging and disruptive floods, often leading to losses of tourism days and critical infrastructure, such as roads. The loss and damage of roads have been witnessed in other parts of the continent, such as in Zimbabwe's Hwange National Park [71]. Flooding in Maasai Mara is often more pronounced during El Nino years as it tends to bring more rainfall than usual to the area as opposed to what one would experience in Southern Africa, which undergoes severe droughts during this time, often resulting in the drying of water holes and resulting in food shortages for animals [1].

Heavy rainfall and floods cause the most damage to tourism in the MMNR, as indicated in Figures 7–9. This concurs with findings about flooding in other tourist destinations, such as various national parks in South Africa [72] and the Yellow Stone National Park [73]. This contrasts with other parks in Kenya, such as the Tsavo East and West National Parks, where extreme drought is the main climatic challenge to tourism [74]. From a management perspective, interviews show that the loss and damage arising from floods and heavy rains are huge and costly to mitigate. Some interviewees cite repairing and maintaining roads and bridges as their greatest costs.

Evidence of increasing daily rainfall intensity points to future challenges for parks from a tourism perspective. There is a need to rethink tourism operations during months and days when extreme rainfall events occur. The park must improve its infrastructure by investing in improved road construction and maintenance techniques. Therefore, there is a need to develop designs that can withstand heavy rain. Stronger and more resilient lodges should be established in areas not prone to flooding as part of the climate change adaptation strategy. Building back stronger and better should form part of the sector's effort to build back better. Building back stronger and better is a concept being punted as one of the steps the tourism sector should adopt as part of a climate resilience effort in building sustainability in tourism [12,75].

Apart from the damages imposed by intense rainfall activity, it is found that the occurrence of mild droughts and shifts in temperature and other climate variables, while not statistically significant, can have far-reaching impacts on some of the most popular tourism activities and animal migration events [76], which are key tourism attractions in

the game reserve. This study did not look at whether the number of rainy days is increasing or decreasing, as this impacts park accessibility due to the gravel roads. This factor is critical to know, given its impact and spillover effect on tourism activities in the park. In that light, it is equally critical for tourists to bear the climate and weather disruptions when planning their trips to the park. Travel insurance is a critical option for tourists and tourism businesses to mitigate against unforeseeable losses. Tourists' flexibility in visiting nature-based tourism destinations is necessary.

Years of average and below-average rainfall reported by key informants often result in increased human–wildlife conflict with the neighboring Maasai community as they seek grazing land in the borderless game reserve. Conversely, wild animals break out to areas that are occupied by human settlements in surrounding communities. This development is a combination of increased host community population and climatic factors. In this light, there is a need to balance conservation and human development needs delicately. The extension of buffer zones through the creation of private game reserves is a commendable development in managing animal and climatic pressure, but there is a need to ensure that the taking and repurposing of communal land are performed fairly and transparently; that is, benefits are equitable and shared to ensure that the less privileged and less politically powerful benefit like anyone else from such schemes. This will assist in harmonizing relations between conservancies and host communities and ensure peace and sustainability in line with SDG 16; there will be peace, justice, and strength in institutions.

The stakeholders of MMNR might also need to rethink tourism and ensure that there are diverse tourism activities on rainy days, such as indoor activities. There is an equal need to deploy early warning systems to provide up-to-date warnings to tourists and other stakeholders in advance to reduce the loss and damage associated with intense rainfall. Technology integration in destination management is important, as it is increasingly used to forecast weather events in tourism destinations [77].

The increased risk of erosion in reserves is another critical concern that requires attention. To reduce soil loss, there is a need to invest in research and designs that effectively deal with erosion challenges in areas of high human and animal traffic. Disaster preparedness and management must be built to better respond to floods and other disasters, such as fires. The savannah ecosystem is vulnerable to fire.

The study revealed that climate change is not included in the MMNR plan for 2023–2032, indicating that management needs to prioritize planning. This lack of consideration concurs with sentiments [8] that tourism stakeholders tend to prioritize other threats and strategic issues that differ from the current attitude toward climate change. A lack of climate action integration in tourism policy and planning has been noted by Becken et al. [58].

6. Conclusions

The study sought stakeholders' perspectives on climate-related threats, impacts and challenges in managing tourism amidst climate change events in the Maasai Mara National Reserve. The study revealed that climate change affected tourism in MMNR, with heavy rainfall and the resulting flooding posing the highest risk, followed by drought. These threats impacted tourism within MMNR in various ways. They caused damage to infrastructure, especially roads, bridges, and accommodation facilities. They also increased erosion, human–wildlife conflict, and vulnerability to wildfires. They also disrupted outdoor tourist activities, dampening the safari experience for tourists. It further emerged that the MMNR faced some challenges in dealing with the impacts of climate change on tourism. The key challenges included an early warning system, research and expertise, a lack of prioritization of climate change in policy and planning, a lack of sustainable land management practices, and the high cost of maintaining roads and bridges.

Consequently, it was prudent that the destination took a more proactive stance regarding preparedness and resilience-building against future occurrences. Recommended measures included infrastructure improvement and fortification, better maintenance systems for infrastructure, product diversification, investment in research to inform stakeholders,

investment in sustainable land management practices, and the implementation of early warning systems. The study further recommended that for the MMNR and businesses within the park, interventions should be instituted for losses and damages caused by extreme weather events, such as budgeting for insurance and allocating funds for disaster management. Regarding policy, it was evident that stakeholders should have treated climate change with the urgency it deserved. The MMNR must prioritize and incorporate climate change issues in its planning processes. Disaster preparedness and management plans were considered important to better respond to extreme weather events like floods.

While opposed to the tarring of the reserve, the damage caused by roads on the landscape and terrain requires a rethinking of this strategy to ensure soil and water source preservation. The constant maintenance of roads throughout the year is particularly disruptive and an eyesore to tourists. There is no doubt that this exercise is expensive and takes millions of dollars. Bridges and road infrastructure require a revision of building codes and standards to integrate current climatic realities, which are adapted and resilient. Given the vulnerabilities of accommodation establishment, a proactive approach is needed to build climate-smart accommodation infrastructure in the reserve. The extremes are such that the reserve is constantly drying and wetting. While rainfall allows for grass stratum growth, it fuels fires in this savannah ecosystem. A proactive approach to fire management is needed to deal with the drying and temperature increase, creating ideal conditions for fire outbreaks.

This study had certain limitations. To begin, it did not include the perspectives of demand stakeholders, such as tourists. It was also limited to wildlife tourism. To this end, the study suggested that future research should expand the scope to include the perspectives of tourists and other forms of tourism, such as coastal and mountain tourism. The paper did not analyze data about other climate threats, such as drought. Future studies should analyze these other threats to provide a more holistic perspective. The climate data were based on satellite data, which had known limitations concerning the standard errors contained within.

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