

A critical analysis of tourism as a vector and victim of climate change: A review paper

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Abstract

This study provides a critical conceptual discussion on how tourism simultaneously acts as an agent and a victim of climate change, using East Africa as a case example. The study seeks to discuss the environmental, economic, and social dimensions that render tourism an agent of climate change while facing adverse consequences from it. Multiple theories guide the study, such as the Tourism Area Life Cycle (TALC), Ecological Modernization Theory (EMT), Political Ecology, and Resilience Theory. Methodologically, the study undertakes an interpretive review of secondary literature and case studies through a qualitative lens on issues of tourism's carbon emissions related to land-use, infrastructure development, and vulnerability to climate-induced disruptions. The study brings out the fact that while tourism is considered a large-scale GHG emitter chiefly through transport and infrastructure development, paradoxically, it causes severe ecosystem degradation and infringement of the interests of marginalized populations, especially from the Global South. Tourism, by nature, adapts to its landscape and climate and is thus at risk of rising sea levels, unpredictable weather, and biodiversity loss, thereby threatening nature-based tourism destinations. The study, therefore, makes several contributions. At the theoretical level, it builds a nexus of fragmented theories to explain tourism's feedback relationship with climate change. It underlines the need for low-carbon technologies, community-based adaptation, and ecosystem conservation at the practical level, while also drawing on the fractured governance landscape at the policy level, championing multi-level climate-tourism governance that is accountable, resilient, and inclusive. In conclusion, the study articulates the incompatibility of the current growth-based tourism model with environmental sustainability. Without transformative changes, it will inadvertently contribute to the degradation of ecological integrity and thus to economic livelihood. It has recommended degrowth as one of the surest ways to bridge tourism development with global climate goals, mainstreaming climate resilience into tourism planning, institutional capacity building, and multi-sector governance.

Keywords: Tourism; Climate Change; Carbon Emissions; Resilience; Sustainable Tourism Governance

1. Introduction

The position tourism holds within the climate discourse is ironically both very central: it is at one end, a driver of climate change, while on the other, it is one of the most vulnerable victims of climate change. Developing countries, especially those in East Africa, where tourism is held as the backbone for economic activities and a sensitive environment, further emphasize this contradiction and present an utmost challenge to sustainability. While tourism is raised as a development mechanism and a solution to the problems of poverty, it accounts for about 8% of greenhouse gas emissions into the global atmosphere, principally due to air travel, energy-intensive hospitality businesses, and unsound land-use practices (1,2). The ever-growing tourist traffic, especially into developing countries, has seen the birth of carbon infrastructure in fragile ecosystems, further worsening environmental degradation and magnifying climate risks (3,4).

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On the other hand, it is now increasingly being threatened by the same climate-related risks that it helps to increase. The destabilization of core tourist assets such as wildlife reserves, coastal areas, and scenic landscapes has indeed begun in East Africa due to shifting rainfall patterns, sea-level rise, biodiversity loss, and extreme weather events, all brought about by climate change(5,6). While wildlife- and coastal-based tourist activities presently contribute to the economy in Kenya, Tanzania, and Uganda are at risk of decline as degradation of the ecosystem erodes visitor experiences and destination competitiveness(7,8). Furthermore, the limited adaptive capacity of the region further aggravates these effects, limited by institutional weaknesses, a scarcity of climate finance, and poor integration of tourism into wider climate adaptation strategies (9,10,5).

The dual vulnerabilities of tourism being both a perpetrator and victim enhance and maintain a feedback loop where tourism feeds climate change and suffers the consequences of climate change, undermining environmental integrity and socio-economic resilience(11). Despite this emergency condition, policy action remains fragmented, of short-term remedies only, and altogether divorced from systemic climate adaptation objectives. This critical review interrogates the structural contradictions that underpin tourism's climate relationship, focusing specifically on East Africa. It assesses the shortcomings of current adaptive responses, identifies gaps in governance, and calls for a transformative change in tourism development that balances economic ambitions with climate justice and environmental stewardship.

1.1. Theoretical Underpinnings

Understanding tourism's dual role as both a driver and recipient of climate change necessitates a robust theoretical framework. Several theories explain the nexus between tourism and environmental impact.

Tourism Area Life Cycle In 1980, Butler developed the Tourism Area Life Cycle theory to explain how destinations come to the fore and proceed through several stages: exploration, involvement, development, consolidation, stagnation, and either decline or rejuvenation. When applied to climate change, destinations in consolidation or stagnation phases (coastal resorts or overcrowded parks, for instance) experience enhanced environmental pressures through overdevelopment and mass tourism. The destinations can decline through one climate effect or another if emissions and environmental degradation caused by tourism continue to increase: the bleaching of coral from warming oceans and droughts, for example. Or these destinations can be boosted through adaptation, perhaps through eco-tourism or green infrastructure. Therefore, the Tourism Area Life Cycle discloses how the trajectory of tourism growth, if left unchecked, promotes climate vulnerability, and where it can be strategically interjected to arrest decline and provide a glimmer of hope to sustainability in other East African high-risk regions (5).

Ecological Modernization Theory, coined by (12), argues that economic development can be compatible with environmental protection through technological innovation, policy reform, and green market transitions. For the tourism-climate nexus, EMT suggests that carbon-intensive tourism can be transformed into a sustainable system through the adoption of low-emission technologies, eco-certifications, and integrations of renewable energy sources (13). Solar power can replace diesel generators in such instances, as does the promotion of green public transport and hospitality resource-use models as mechanisms to address climate concerns without compromising economic growth (14). Conversely, however, opposers feel that EMT might wash aside questions of structural inequalities, as well as neglect the growth of the rebound effect, in which efficiency gains are nullified by consumption gains. Meantime, the EMT for tourism remains useful but must be supplemented with systemic behavioral changes and stronger governance (15).

Political Ecology views (upon) Departure (2004, 2019) environmental issues as being structured by power relations, economic interests, and social inequalities. Environmental issues are political and economic, not just ecological. Environmental degradation is often rooted in unequal power relations and political decisions, not merely poor resource management. In tourism, it critically exposes how climate vulnerabilities are unevenly distributed. Tourism-driven emissions disproportionately stem from high-income travelers and luxury developments, while climate consequences—such as water shortages or ecosystem degradation—are borne by marginalized communities in host regions like East Africa (16). Political Ecology critiques how tourism infrastructures often displace local livelihoods, prioritize investor interests, and deepen social inequities, especially concerning resource allocation and climate adaptation. It brings to light issues such as regulatory enforcement failures and instances of greenwashing, which are actually symptoms of deeper structural imbalances (17). Applied here, Political Ecology challenges the dominant growth model and calls for equitable, community-centered, and justice-informed climate responses in tourism governance.

Resilience Theory The theory of resilience, initiated by Holling (18), is concerned with the existence of the capacity of systems (ecological, social, or economic) to absorb shocks and adapt to changing conditions to remain functioning. The theory connects with tourism and climate change and centers on the establishment of systems able to absorb shocks

deriving from environmental disruptions, such as floods, droughts, and biodiversity losses (19). In the case of East Africa, resilience thinking promotes diversification of tourism products (e.g., cultural tourism), development of community-based tourism, and strengthening of local governance. It also markets activities for regeneration and habitat restoration as well as infrastructure resilient to climate change (19). Resilience Theory focuses on forward-thinking strategies for adaptation, as opposed to reactive responses, in recognition of the non-linear and unpredictable character of climate hazards (20). However, resilience without equity risks reinforcing existing power structures. Thus, resilience in tourism must be socially inclusive and ecologically restorative to ensure long-term sustainability.

2. Tourism as a Vector of Climate Change

2.1. Carbon Footprint of Tourism Activities

Tourism greatly contributes to global greenhouse gas emissions from energy use and carbon-heavy activities. According to Islam (21), tourism accounts for some 8% of the total carbon emissions throughout the world, while air transportation remains the chief source. Tourism activities often include accommodation, food services, and other recreational activities. These activities normally require fossil fuels and therefore the more they run on them, the more they increase their impact on the environment (22). Luxury resorts require enormous energy demands and produce their waste, cruise ships along with large events produce further waste and more emissions wherein tourism-related carbon footprints are further exacerbated (23). It only goes further with serial overconsumption of water and energy resources, particularly in dry areas, more carbon emissions are generated in pumping, heating, and treatment (24). Moreover, the expansion of tourism into remote and sensitive areas has introduced emissions where previously none existed. For instance, in East Africa, safari tourism activities inside national parks produce emissions through 4WD use and air transfers, all with little offset or regulation. After many years of discussions on the topic, the adoption that apes low-carbon alternatives remains limited, especially in developing countries where tourism plays an important role in economic growth (25) In spite of all this, "the gap between carbon consciousness and behavior continues to challenge the sector's environmental responsibility". From this, following the carbon-intensive character of tourism, there must be mitigation at systemic levels and accountability throughout the sector in regard to carbon.

2.2. Contribution of Transportation and Infrastructure

Transport services contribute the highest emissions under the tourism vertical—a share of generators reaching nearly 75%, with aviation contributing slightly over 40% (26). The growth demonizes long-haul air travel, short-haul air travel, cruise tourism, and their private vehicle use in burning more fossil fuel. Thus, infrastructure development, including airports, roads, and hotels, entails vast land alteration on one instance and energy inputs, leading to indirect emissions on both construction and operation phases (27,28). In emergent tourist markets such as East Africa, the infrastructural expansion occurs in ecologically vulnerable lands that include coastlines and protected reserves, thereby promoting deforestation, habitat fragmentation, and heat island effects (29). Moreover, the off-grid lodge infrastructure that terribly relies on diesel generators only worsens the emissions situation where areas for the lack of renewable energy (30). The name of accessibility seems to outshine all other environmental considerations during the planning phase, which results in carbon lock-in because of long-term commitment to car-based or air-based travel systems (28). Rarely would tourism planning prioritize public transport and modes of non-motorized transit anyway, especially in rural and peri-urban regions. The way tourism is mounting, at this point, focusing on transportation and infrastructure would be an axis through which the industry furthers climate change unless green mobility and resilient urban design alternatives prevent it.

2.3. Land Use Changes and Ecosystem Degradation Caused by Tourism

Tourism development comes with land use changes leading to ecosystem degradation and thus indirectly contributing to climate change by diminishing carbon sinks such as forests, wetlands, or mangroves. Coastal development, golf courses, and resort complex, etc., are frequent causes of deforestation, alterations of habitat, and hydrological systems (31). In East Africa, deforestation for safari camps and lodge development surrounding national parks destabilizes carbon storage functions and wildlife migration corridors (32). Similarly, activities of marine tourism, such as diving and snorkeling, can damage coral reefs, thus reducing their capability of carbon sequestration and undermining marine biodiversity (33). In areas like Zanzibar and the Kenyan coast, mangrove forests crucial for carbon capture have been cleared to give way to hotel construction (32, 34). In addition to paving natural surfaces for roads and airports seals soils altering albedo, thus increasing the effect of local warming. These land changes kick in the worsening of both ecosystems and human communities to climate-related risks such as floods and droughts (35). Poor regulatory enforcement with an attitude of economic prioritization rather than ecological balance all worsen these challenges. So, tourism-driven land use changes exacerbate environments and reduce natural systems' ability for resilience with climate change.

2.4. The Critiques on Emissions and Resource Use by Tourism

An increasing number of critics debate tourism's role in climate change in the light of its disproportionate environmental footprint compared to its economic benefits. Critics often contend that the sector, by promoting unsustainable consumption patterns, favors short-term profits against long-term ecological integrity (36,37). Heavy resource usage-fuel energy consumption and water consumption- in tourist facilities pressures local supplies, quite often at the expense of local communities (38). In various destinations of the Global South, tourist development has access to resources, thereby generating social problems and act against equity (39). Besides, tourism marketing has also glorified energy-intensive activities such as luxury travel and adventure tourism, ignoring their environmental costs. Corporate greenwashing has also been addressed: many operators engage in half-baked environmental initiatives while evading genuine emissions reduction. Though very much marketed, carbon offsetting schemes are accused of granting moral licenses to pollute something that prompts systemic change. Also, authorities in charge of destinations generally do not have a firm environmental monitoring framework; thus, accountability is extremely limited (40). The current tourism growth model entertained toward continuous expansion at odds with the climate agenda. Without transformative policy shift and more robust regulatory enforcement, the tourism sector will remain a major hurdle to achieving emission reduction targets on the global stage. Hence, a critical rethinking of tourism's growth paradigm is imperative.

3. Tourism as a Victim of Climate Change

3.1. Climate Change Impacts on Tourist Destinations

More and more tourist destinations become vulnerable to the multifaceted impacts of climate change, which include, among others, sea-level rise, temperature variations, episodes of extreme weather, and ecosystem disturbances. Concurrent with and complimentary to the perceived threats of sea-level rise, coastal and island destinations also face beach erosion, saltwater intrusion, infrastructural damages, and other threats, which compromise the aesthetic and functional appeal of these destinations (41,42). Mountain areas dependent on snow and seasonal tourism are facing shorter snow seasons and less snow reliability due to warming (43). In East Africa, altered rainfall patterns and prolonged droughts affect the drought resistance of wildlife to water, decreasing the attraction to safari tourism(44,45). These climatic changes threaten the environmental basis on which tourism is dependent, thereby threatening the very existence of many tourism-dependent economies. Moreover, coral reef destinations in the world have been subjected to mass bleaching from ocean warming, threatening marine biodiversity and underwater tourism (7). Decreases in environmental quality lower the standards of tourist satisfaction, which repeat visitation upon is the question of concern about revenue generation; therefore, tourism is at risk from climatic variability. Hence, climate change disrupts the physical environment and also degenerates the core resources that entice tourists, thereby making it critical for the adaptation of destinations toward sustainability.

3.2. Economic and Social Vulnerabilities of Tourism-Dependent Communities

Tourism-dependent communities often face serious economic and social vulnerabilities due to climate change because they depend on nature-based attractions and seasonal income. Many such communities have little economic diversification and are therefore highly susceptible to any environmental shocks (46,47). In developing regions such as East Africa, dwindling tourist numbers due to climate-associated impacts like drought, flooding, or disruptions of wildlife migration threaten the livelihoods of local communities, especially those in households involved in ecotourism, guiding, and artisanal sectors (48,44). Loss of income causes further poverty, food insecurity, and health risks especially to rural and other marginalized populations (49). Further, tourism job losses are gendered, for women mostly are in low-paying and informal tourism jobs and have fewer social safety nets (50). These social vulnerabilities are compounded by the erosion of social cohesion, displacement through climate events, and reduction in access to key services (51). Adaptive capacity is also constrained by the lack of financial resources, weak governance structures, and infrastructure. Due to this, the foregoing environmental risk intensifies pre-existing socio-economic inequalities in tourism-dependent communities, and hence requires an equity-focused adaptation approach that also addresses social resilience and inclusive development.

3.3. Case Studies of Climate Change Touching Tourism in East Africa

With its world-renowned biodiversity hotspots and natural heritage sites, East Africa is a textbook example of tourism being either a contributor to or a victim of climate change. Ecological disturbances severely impact this region because of its reliance on nature-based tourism.

Flood incidences and seasonal rainfall variability have brought in migration and vegetation changes, thereby impacting wildlife viewing experiences in parks such as Queen Elizabeth and Murchison Falls. Floods also hamper road networks and access to key tourism sites, causing higher costs of operation and increased travel risks.

Climate change has affected the migration patterns of wildlife at the Maasai Mara National Reserve in Kenya (52). Droughts exacerbated by climate change have suppressed water availability further, altered vegetation dynamics, and aggravated conflicts between humans and wildlife to the detriment of both tourist experiences and ecological integrity (48, 44).

Beach resorts and centers of marine tourism are at high threat from sea-level rise and coastal erosion in coastal Tanzania and Kenya (53). The historic Stone Town of Zanzibar, a UNESCO World Heritage Site, is further threatened by saline intrusion and physical degradation triggered by recurrent tidal flooding and rising sea levels (54). In a similar vein, coral bleaching in East African marine parks, especially Mafia Island Marine Park and Watamu Marine National Park, has affected the marine biodiversity negatively, lowering the appeal for diving tourism and thus compromising the livelihoods dependent on ecotourism (55, 56).

The mountain gorilla tourism of Uganda, located in Bwindi Impenetrable Forest and Mgahinga Gorilla National Park, risks being precipitated by climatic alterations in habitat and disease threats. Both warmer temperatures and shifts in rainfall patterns bring threats to gorilla health while increasing the risks of zoonotic disease transmission due to greater proximity of humans to wildlife (57). Furthermore, tourism infrastructure in these remote places is usually ill-prepared for extreme weather events like landslides and flash floods, severely disrupting access and safety.

Conversely, the carbon emissions from increasing international arrivals and poorly controlled safari tours add substantially to the regional greenhouse emissions. Off-road driving in fragile savannahs causes vegetation loss and soil compaction, all of which contribute to further degradation of these ecosystems (58). Similar tourism facilities are operating at high energy and water demands, especially in the arid regions of northern Kenya and parts of Tanzania.

But new models of community-based tourism in Rwanda and Uganda are advancing sustainable practices such as low-impact lodges, waste recycling, and reforestation activities funded through ecotourism revenue. Nevertheless, East Africa requires stronger integrated regional interventions and investment in climate-resilient infrastructure to protect its tourism economy and environmental heritage.

3.4. Adaptation Challenges and Responses in the Tourism Sector

Adaptation faces a plethora of challenges in the tourism sector; these include lack of financial means, knowledge gaps, institutional inertia, and fragmented governance. SMEs make up most of the tourism sector in many developing countries and often simply cannot afford to conduct any kind of climate adaptation or lack the technical know-how to do so properly (59). On the other side... the short-term nature of planning in the sector, with businesses more concerned about short-term profits than long-term sustainability, is weakening any effort toward proactive climate planning (60). Additional barriers are weak policy coordination, lack of climate data, and limited community-level stakeholder engagement regarding adaptation efforts in East Africa (61).

In spite of these challenges, coping strategies are beginning to emerge: management plans for shorelines and sea defenses are being put in place for coastal destinations. Diversification of tourism products and better habitat conservation are targeted at sustaining existing wildlife-based tourism attractions (62). Certification programs such as Green Globe and Travelife foster sustainability standards, while climate risk appraisals get increasingly embedded into destination management plans (63).

Yet, the bulk of adaptation measures are reactive and underfunded. There is, therefore, a need for the wider integration of climate concerns in tourism development frameworks, supported by inclusive governance structures and access routes to climate finance. Unless climate shift adaptation is done systematically, greater losses from the present and future impacts of climate change will be sure to hit the tourism sector.

3.5. Summary of the Review and Gaps in Current Research and Practice

Despite increasing scholarly and policy attention on tourism and climate change, several critical gaps stubbornly remain. First and foremost, the existing literature usually touches on tourism's contribution to climate change in fairly broad terms, generally focusing on global emission statistics and broad mitigation strategies (21,26). In this context, there is still a dearth of region-specific analyses of how tourism functions as an emission vector. In a diversity-rich

setting like East Africa, absent region-specific carbon accounting tends to obscure localized emission sources and consequently weaken mitigation policy formulation (32, 24).

Second, policy responses are largely mitigation-based, with the equally urgent imperatives for adaptation being largely overlooked. Shoreline protection and product diversification appear as examples of adaptation measures, but their implementation varies across the board and much of the time they do not make it to the national climate agenda (61, 62). More so, adaptation measures fail to account for the needs of small-scale tourism enterprises and local communities who are highly vulnerable but critical to the sustainability of tourism (59,46).

Third, what little is examined regarding the link between tourism-relevant land-use changes and ecosystem degradation remains overlooked in climate discourse. The ecology of deforestation, conversion of mangrove ecosystems, and wetlands into tourism infrastructure soils in the East African region is sufficiently unknown, notably on how such changes may, in the long term, contribute to climate change and biodiversity loss (31). Undeniably, the tourism sector's carbon footprint is understated as it somehow disregards the indirect emissions occasioned by land transformation and resource overuse.

Fourth, the theoretical integration in climate-tourism studies is quite limited. Most of the studies have instead isolated tourism's environmental impacts unfamiliarized or without attempts to further develop theoretical frameworks such as Ecological Modernization Theory (EMT) or Political Ecology. This poses a limit to their potential in developing and critically reflecting on the socio-political drivers of environmentally harmful tourism practices (37). Nary are there studies that apply rigorous quantification in analysing how power asymmetries, greenwashing, and policy failures sustain unsustainable tourism models, more so in the developing countries.

Fifth, the empirical studies of climate vulnerability have not sufficiently managed an intersectional depth in tourism-dependent communities. The gendered and class-based expressions of climate vulnerability, as in the disproportionate impact on irregular, poorly paid tourism workers, remain insufficiently explored(50,51). This negates social resilience as a vital concept in destination-level adaptation and risks reinforcing systemic inequality.

Lastly, less is written on scaling-up this micro-level sustainability innovation. With promising ventures in eco-lodges, low-waste initiatives, and reforestation in Rwanda and Uganda, there remains a dearth of discussion as to how these models can be institutionalized at a policy and regional level (55). The result is a disjointed knowledge base that is weak in informing change at the systemic level.

In sum, this calls for serious attention to the critical gaps that are: (i) regional emissions profiling, (ii) the integration of adaptation into tourism planning, (iii) theoretical development, (iv) the social dimension of vulnerability, and (v) scaling up community-based sustainability innovations. It is necessary that these gaps be addressed for a more just and climate-compatible tourism future.

4. Contributions

4.1. Contributions to the Development of Theory

This study advances the theory in four main ways. The first extension is to the Tourism Area Life Cycle (TALC), which is expanded to accommodate climate-driven destination decline in nature-dependent areas such as East Africa, hence affirming Butler's (1980) model in respect to contemporary climate stress. Second, the integration of Ecological Modernization Theory (EMT) reveals how technological fixes can never fully compensate for tourism's environmental costs, especially in a context of a developing nation, where green infrastructure is poorly developed (21). The third set of contributions strengthens the Political Ecology framework by revealing the power asymmetries that mark tourism resource use, wherein elite tourism projects gain access to resources at the expense of vulnerable communities (39). Fourth, Resilience Theory is expanded through the concepts of adaptive capacity and social vulnerability within tourism-dependent communities, moving out of the realm of ecosystem recovery to include human well-being and governance constraints (51). These theoretical movements and integrations offer a more integrated perspective toward the relationship of tourism and climate.

4.2. Contribution to Policy

As implications for tourism-climate policy, the study indicates that rather than focusing on incremental change, the appropriate approach must be one of transformation. Current mitigation strategies, which concentrate on offsetting and voluntary standards, are found wanting as this study posits that mandatory carbon accounting and regional-level

emission reductions should be implemented in tourist hotspot regions (10,40). The findings thus advocate for the formation of land-use and tourism policy integration aimed at preventing ecosystem degradation, especially in buffer and coastal areas. Additionally, they support investments in climate-smart infrastructure planning emphasizing green mobility, energy efficiency, and environmental impact assessments prior to approval of developments (29). It further calls for improved policy coordination between ministries responsible for tourism and the environment, especially in an East African context where fragmented governance limits climate resilience (61). Additionally, it puts forward an approach whereby tourism taxes max out international climate financing mechanisms for securing equitable adaptation and biodiversity conservation in tourism-dependent zones.

4.3. Contribution to Practice

For tourism practitioners, the study offers practical guidelines on how best to lessen environmental impacts while building climate resilience. The study urges tourism operators to pursue low-impact options such as eco-certification, waste reduction, and water-efficient technology with emphasis on their local context (63). More pressure needs to be worked on changing promotion away from glamorized, energy-intensive tourism toward truly sustainable experiences. Diversifying the products might be one way of achieving this by reducing pressure on the ecosystem over the peak wildlife seasons whilst maintaining visitor numbers. When working with local communities in climate adaptation planning, practitioners should consider those communities' potential in ongoing ecosystem management and crisis response activities (55). The study has developed a framework that sets climate risk assessments into business continuity planning as a priority, particularly for SMEs. By committing operational activities to climate goals, tourism businesses improve their prospects of survival in the next few decades, while contributing to local development and environment preservation.

5. Conclusion

Eastern Spa-In this complex dualism, Tourism is a cause of climate change and a victim of its impact. Through means of transport emissions, tourist infrastructure expansion, and land-use changes, tourism, either impetuously or not, perks up the environment stretch and fills up the atmosphere with carbon. On the flip side, without which climate change basically is without a purpose as it threatens ecosystems, experiences, and alike economic sectors that sustain the industry. Destinations are beset with sea-level rise, loss of biodiversity, and altered weather patterns affecting flurries of tourism and blocked way for livelihoods. The study shows profound theoretical, operational, as well as policy gaps in tackling these intertwined issues. Several responses have emerged in the form of localized interventions and adaptation, but the sector remains largely reactive, disjointed, and unprepared. A real pivot toward climate justice, resilience, and sustainability in tourism is not just desirable but urgent. The shift will require systemic policy reform, grounded theoretical integration, and the recognition of low-carbon development pathways in practice.

Recommendations

As recommendations toward pursuing tourism development in concert with climate imperatives, this study proposes

- Mandatory carbon audits and emission caps. Governments should institutionalize carbon accounting frameworks for tourism businesses, particularly those within national parks, marine reserves, and heritage sites. Mandatory enforcement must accompany currently voluntary offset schemes to ensure that offsetting achieves real reductions.
- Integrated climate-resilience tourism master planning. Planners should prioritize climate risk assessments, green infrastructure, and ecosystem restoration programs in zones of tourism. Zoning restrictions should bar construction development in flood-prone or ecologically sensitive areas.
- Green mobility corridors developed on a regional scale. Investments must be channeled toward electrified public transport, bicycle infrastructure, and regional rail networks in a bid to discourage local reliance on aviation and road travel. Incentives to the smooth transition of clean energy in tourism transport are vital.
- Support to community-based climate adaptation. Redirect tourism revenues and climate funds to adaptively building the capacity of local communities, including women and informal workers; empower them through education and training and give them access to microfinance supporting green entrepreneurship.
- Strengthening intersectoral policy coordination. Tourism-climate task forces and regional cooperation platforms should be established to align infrastructure development, environmental protection, and tourism growth-related goals.
- The implementation of these measures can take the sector from reacting to climate perturbations to proactively engaging in climate action.

Limitations of the Study and Areas for Further Research

The study is limited by its dependence on secondary data and region-specific case studies, which may not fully capture the diversity of tourism-climatic dynamics across East Africa. By undertaking empirical fieldwork involving direct emissions measurement and community interviews, a strong addition to the findings would be made. Moreover, the study does not deeply commit itself to mechanisms of tourist behavior change or technological innovations such as AI for sustainability management. Future research could address the long-term effects of climate adaptation policies on tourism resilience, the sustainability of small enterprises through climate finance, and comparative regional studies across the Global South, thus focusing on the development of more generalizable strategies.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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