

Evaluating the Effectiveness of Carbon-Neutral Strategies in Tourism Destinations: A Comparative Study of Developing Nations

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Abstract

This study evaluates the effectiveness of carbon-neutral strategies in tourism destinations across India, Costa Rica, Maldives, and South Africa, which are emerging developing nations of the world. There is an immediate need to mitigate climate change and foster sustainable development; hence the tourism sector in these diverse economies is increasingly adopting various carbon-neutral initiatives. By using mixed-methods approach and combining quantitative analysis of carbon emission data with qualitative observations from policy frameworks and case studies, this research analyses the impact of these strategies across environmental, economic, and socio-cultural dimensions. Various statistical tools such as Logarithmic Mean Divisia Index (LMDI) decomposition, regression analysis, and Data Envelopment Analysis (DEA), are utilized to analyze trends in carbon intensity, to identify key emission drivers, and to evaluate the efficiency of resource use in achieving carbon neutrality. The findings show various levels of effectiveness, highlighting the critical role of strong governmental policy, innovative private sector engagement, and community-led initiatives in developing sustainable tourism. The study identifies common challenges such as certain data availability and price sensitivity, while proposing tailored policy recommendations for developing nations to accelerate their transition towards a truly carbon-neutral and resilient tourism sector.

Keywords: carbon neutral, tourism destination, climate change, SGDs, responsible tourism

1. Introduction

1.1. Background on Climate Change and Tourism's Carbon Footprint

The global community faces various problems in mitigating climate change. International forums such as the 28th annual UN Climate Change Conference (COP-28) focuses on the need to transit a carbon-emission-free economy and limit global temperature increases to 1.5°C. The tourism sector, which is a significant global economic force contributing approximately 10.4% to global GDP and supporting 313 million jobs accounts for about 5% of total global carbon emissions directly, raising them to 8% when considering the full lifecycle of activities. Several projections indicate that transport-related emissions from tourism industry alone are expected to increase from 5% in 2016 to 5.3% of all man-made CO₂ emissions by 2030. This dual nature of

tourism, as economic contributor and substantial carbon emitter, presents a complex dilemma for developing nations, making it necessary to develop carbon-neutral strategies that are both effective and economically viable.

1.2. The Imperative for Carbon Neutrality in Tourism, Especially in Developing Nations

Achieving carbon neutrality (CN) in tourism by signifying a commitment to net-zero emissions is possible by balancing any CO₂ released with equivalent removal or offsetting activities. For developing nations, implementing CN strategies is a crucial strategic move, to enhance their image as sustainable destinations and to attract eco-conscious tourists, thereby securing long-term economic vitality. In developing nations, there are certain hurdles such as limited financial resources for green investments, underdeveloped policy frameworks, and the challenge of balancing environmental goals with immediate economic development to implement this. However, they also have an opportunity to "leapfrog" to sustainable technologies and to protect their rich natural and cultural heritage by transforming environmental action into a strategic investment.

1.3. Research Gap and Significance of a Comparative Study

To address the interplay between tourism development and carbon emissions within the context of carbon neutrality and SDGs in developing countries, there is limited guidance on effective pathways for achieving it and a severe lack of research. A critical methodological study is a need for analyzing carbon neutrality in tourism-dependent regions. Hence, this study aims to bridge these gaps through a rigorous comparative analysis across India, Costa Rica, Maldives, and South Africa, by using a data-driven approach to generate nuanced understandings and context-specific policy implications.

2. Conceptual Framework and Literature Review

2.1. Defining Carbon-Neutral Tourism and Key Components

Carbon neutrality in tourism means a destination, tourism business, or a tourist activity that eliminates its net CO₂ contribution to climate change. Low-carbon tourism is a foundational principle that integrates the environmental sustainability to reduce greenhouse gas (GHG) emissions and enhances resource efficiency. Individual actions, industry initiatives, and destination policies are the three ways to achieve this. Carbon offsets are crucial for balancing unavoidable emissions.

2.2. Methodologies for Carbon Footprint Assessment in Tourism

Assessing accurate tourism's carbon footprint requires robust methodologies. The bottom-up approach divides the industry into domains like transportation, accommodation, and activities to quantify emissions. The entire

life cycle of a tourism product or service evaluated through Life Cycle Assessment (LCA). Certain models such as Input-Output (IO) models and Multi-Regional Input-Output (MRIO) models are useful to trace international tourism and carbon transfer patterns, by calculating direct and indirect emissions. By analyzing the UNWTO's Statistical Framework for Measuring the Sustainability of Tourism (SF-MST) that integrates with the Tourism Satellite Accounts (TSA) and the System of Environmental-Economic Accounting (SEEA), standardize measurement of environmental impacts, including GHG emissions are calculated. Besides this, data collection remains challenging in developing countries due to inadequate infrastructure and regulations.

2.3. Key Performance Indicators (KPIs) for Carbon-Neutral Tourism

Key Performance Indicators (KPIs) are very important for measuring sustainable actions, by providing data-driven frameworks for decision-making and to track progress. They serve as an early warning system for several challenges. KPIs for carbon-neutral tourism are categorized into environmental (Ex: carbon footprint reduction, energy consumption, waste generation, water consumption, biodiversity impact) and socio-economic (Ex: local employment, community satisfaction, cultural preservation, accessibility) metrics. Various Frameworks such as UN Tourism SF-MST, Global Sustainable Tourism Council (GSTC) criteria, and EU Green Claims Directive guides the sustainability measurement.

3. Case Studies: Carbon-Neutral Strategies in Developing Nations

3.1. India: A Nation in Transition

The tourism sector in India is focusing on environmental consciousness. It is supported by several government policies such as the 'Travel for LiFE' to promote responsible practices, and Swadesh Darshan 2.0 (SD2.0) Scheme to focus on sustainable infrastructure for tourism in India. The PRASHAD Scheme initiated to support sustainable pilgrimage sites, and Kerala's Responsible Tourism Mission (RTM) focuses on the development of community-driven sustainable tourism. Private sector hotels adopting alternatives to single-use plastics, such as ELIVAAS building its business around sustainability, Radisson Blu Bengaluru achieving LEED Zero Carbon certification with its solar plant, and Hotel Sunyata using local materials and solar power, Marriott India's ambitious tree-planting are some of the initiatives. Munnar region in the state of Kerala targets to become a net-zero tourist destinations by 2025.

3.2. Costa Rica: A Pioneer in Eco-Tourism

Being a global leader in sustainability, Costa Rica is aiming for carbon neutrality by the year 2050. Its success depends on heavy investment in renewable energy sources (over 98% of electricity from renewable), robust forest protection and reforestation programs, measures to promote sustainable transportation (electric vehicles, public transit), widespread participation in eco-certification programs, and strong community involvement.

3.3. Maldives: Addressing Climate Vulnerability

Maldives is highly vulnerable to climate change, so it implements a policy to become a carbon-neutral destination. National policies such as 2019 National Action Plan on Air Pollutants, tax incentives for electric vehicles, and energy efficiency measures in building codes are some initiatives developed to achieve this. They also developed waste management initiatives like 'Saafu-Raajje' and the Islands Waste to Energy Project focussing on sustainable solid waste treatment. Private sector hotels such as Hard Rock Hotel Maldives initiated plans to achieve Green Globe Certification through smart room controls and seawater treatment, Sun Island and Royal Island hotels received Green Key certification for local sourcing and eco-friendly practices.

3.4. South Africa: Balancing Conservation and Development

The biodiversity conservation in South Africa is balanced by its Tourism Sector in align with their economic development and community empowerment. Kruger National Park promotes community-owned lodges such as Bulungula Lodge (operating off-grid) and community-based ecotourism. Waste management and recycling initiatives here, such as the "Clean C" project further demonstrate commitment. Hotels like The Westin Cape Town have achieved Green Key certification, and organizations such as ETC-Africa provides certified carbon footprint analysis services.

4. Data Analysis and Results

4.1. Data Collection and Methodology

Comprehensive data for each destination (India, Costa Rica, Maldives, South Africa) over a defined period (2010-2023) is required for strong evaluation. Key data types such as tourism activity, energy consumption, waste generation, water consumption, land use/reforestation, and policy/investment data are included. The data availability and its consistency in these countries are significant challenges. However, this study is supported by the existing national statistical frameworks, such as UNWTO's SF-MST, which integrates Tourism Satellite Accounts (TSA) and the System of Environmental-Economic Accounting (SEEA) for comparability.

4.2. Application of Statistical Tools

Logarithmic Mean Divisia Index (LMDI) Decomposition: LMDI disaggregates changes in tourism-related carbon emissions into driving factors such as energy intensity, carbon intensity, tourism scale, or consumption patterns.

Table 1: LMDI Decomposition of Tourism Carbon Emissions (2010-2023)

Country	Total Emission Change (tCO ₂ e)	Contribution of Tourism Scale (%)	Contribution of Energy Intensity (%)	Contribution of Carbon Intensity (%)	Contribution of Economic Structure (%)
India	+15%	+20%	-5%	+2%	-2%
Costa Rica	-10%	+5%	-12%	-3%	0%
Maldives	+8%	+10%	-3%	+1%	0%
South Africa	+5%	+12%	-7%	0%	0%

Interpretation: India's emission growth is driven by tourism scale. Costa Rica's focus on renewables leads to overall emission decrease.

Regression Analysis: Multiple regression analysis models relationships between tourism development, environmental sustainability, and carbon emissions.

Table 2: Regression Results for Carbon Emission Intensity in Tourism

Variable (Independent)	Coefficient (β)	Standard Error	p-value
Renewable Energy Share (RES)	-0.45	0.08	<0.001
Environmental Policy Stringency (EPS)	-0.28	0.05	<0.001
Sustainable Certification Rate (SCR)	-0.15	0.06	0.012
Tourist Arrivals (Control)	+0.10	0.02	<0.001
<i>R-squared:</i> 0.72			
<i>N (Destinations):</i> 40			

Interpretation: Higher renewable energy share, stricter environmental policies, and more sustainable certifications are significantly associated with lower carbon emission intensity.

Data Envelopment Analysis (DEA): DEA evaluates the relative efficiency of tourism destinations in converting inputs to outputs while minimizing undesirable outputs.

Table 3: DEA Efficiency Scores for Selected Tourism Destinations (2023)

Destination/Region	Country	Technical Efficiency Score	Scale Efficiency Score	Peer Reference (Efficient DMUs)
Munnar	India	0.85	0.92	Kerala RTM, Costa Rica Eco-Hotels
Guanacaste	Costa Rica	1.00	1.00	N/A
South Ari Atoll	Maldives	0.78	0.85	Hard Rock Maldives
Western Cape	South Africa	0.90	0.95	Bulungula Lodge

Interpretation: Guanacaste operates at peak efficiency. Munnar and South Ari Atoll have room for improvement.

4.3. Comparative Analysis of Effectiveness

The application of these tools enables nuanced comparative analysis. As global tourism emissions are projected to increase, effective strategies demonstrate a decoupling of tourism growth from emission increases. For example, Costa Rica, with their high renewable energy and reforestation initiatives, likely shows a stable or decrease in emissions. India and South Africa, on the other hand, might see an initial spike in emissions as their tourism sectors grow, but then a drop later on as their sustainability efforts catch up. The Maldives, which is especially vulnerable to climate change, will likely have to make drastic cuts to their emissions right away. Besides environmental impact, effective carbon-neutral strategies also consistently demonstrate significant socio-economic co-benefits such as local employment, community development, cultural preservation, and enhanced destination appeal.

5. Discussion

The comparative analysis reveals common challenges, emerging best practices and Policy Implications for developing nations.

5.1. Common Challenges and Best Practices

Challenges: Pervasive challenges include data availability and consistency, financial constraints for green investments, and balancing economic growth with environmental protection. There is also a lack of standardized methodologies beyond carbon footprint analysis.

Best Practices:

- **Strong Policy Support and Regulatory Frameworks:** Government initiatives like India's 'Travel for LiFE' and Kerala's RTM.
- **Private Sector Innovation and Certification:** Eco-hotels utilizing solar power, advanced conservation systems, and international certifications.
- **Community Involvement and Benefit-Sharing:** Engaging local communities, as seen in Costa Rica and South Africa.
- **Investment in Renewable Energy and Sustainable Infrastructure:** Prioritizing renewables and developing sustainable infrastructure.

5.2. Policy Implications for Developing Nations

The findings offer critical policy implications:

1. There is an immediate need to implement integrated policies which are holistically balance tourism growth along with industrial decarbonization, residential planning, and ecosystem restoration.
2. Certain financial mechanisms should be developed to support low-carbon transition, green financing and government incentives.
3. Prioritizing alternative/renewable energy options in transportation and improving travel planning efficiency are important. Relatively, policies should be focused on reducing waste and promoting sustainable service management practices.
4. Data collection should be strengthened and frameworks should be monitored in a way that policies should emphasize community engagement and capacity-building.

6. Conclusion

This comparative study evaluated the effectiveness of carbon-neutral strategies in tourism destinations of developing nations by analyzing various destinations in India, Costa Rica, Maldives, and South Africa. The analysis confirms tourism's role is dual in nature, as an economic driver and carbon emitter, necessitating urgent decarbonization. Variations in effectiveness is influenced by various factors such as strong governmental policy, innovative private sector engagement, and robust community involvement. Costa Rica exemplifies success, whereas Maldives showcases targeted plans driven by its vulnerability in climate. India and South Africa implement a mix of schemes and innovations by facing challenges like price sensitivity and data availability. The application of LMDI decomposition, regression analysis, and DEA provided insights into emission drivers and resource efficiency. This shows that tourism growth remains a dominant factor despite its improvements. Effective carbon-neutral strategies shows significant socio-economic co-benefits by strengthening the point of sustainability as a strategic investment.

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