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Rainforest tourism: a systematic review of established knowledge and gaps in research

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ABSTRACT

Rainforests provide exceptional spaces for nature-based tourism activities attracting large numbers of visitors. Simultaneously, tourism activities may create environmental, social and economic impacts that require management in order to conserve sensitive rainforest environments. Rainforest tourism constitutes a travel sector that receives growing interest worldwide. This study presents a timely review of current knowledge and research gaps in a new conceptual model to give recommendations for a future research agenda. Through a systematic quantitative review, the study identified 48 peer-reviewed journal articles addressing conservation and management topics (33), followed by visitor-related research (23), impacts (10), and finally community and stakeholder research (3) of rainforest tourism, published between 1975 and 2019. The majority of research focused on management issues relating to policy development, planning, education and conservation measures. A strong geographic bias was noted with very limited research available for rainforest regions in Africa and Asia. Future research should be concerned with expanding and linking rainforest research across countries, and filling knowledge gaps around visitor monitoring, specific impacts and causes, and the complexity of community and stakeholder involvement in managing impacts. Protocols may need to be established to facilitate the design and delivery of standardised research approaches across the globe.

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Rainforest tourism; nature-based tourism; protected areas; systematic review; tropical rainforest; temperate rainforest; ecotourism

Introduction

Rainforests constitute the oldest living ecosystem on the planet, with some having evolved for more than 60 million years (IUCN, 1982). They are the most biologically diverse habitat providing space for two-thirds of the world's animal and plant species (Divino & McAleer, 2009). Two types of rainforest exist across the world, namely, temperate rainforest and tropical rainforest (Figure 1) (National Geographic, n.d & Cunningham & Read, 2002). Temperate rainforests are located around the mid latitudes and found mostly in coastal mountain areas such as in North America (Pacific Northwest), United Kingdom, Japan, New Zealand and the Southern parts of Australia (Fisher et al., 2019). Temperate rainforests receive less annual rainfall (<2000 mm) than tropical rainforests (>2000 mm).

Tropical rainforests were coined as the 'Earth's lungs' due to their oxygen-releasing properties. Located on 15–20° on either side of the equator (Stork et al., 2008), the largest of these rainforests span across the tropics in South and Central America, Africa, Asia, and

Oceania. Among these, the Amazon River Basin in South America encompasses 40% of the global rainforest cover. Emphasising their endangered status, UNESCO has declared 17 rainforest sites as world natural heritage in the 'danger' category.

Rainforests also provide exceptional spaces for nature-based tourism activities supporting a flourishing tourism trade (Yu et al., 1997). In fact, many developing countries have become reliant upon nature-based tourism in rainforest settings offering flora and fauna observation tours, hiking and camping activities (Henning, 1993; Makoni & Chikobvu, 2018). This however has led to physical, biological and social impacts placing pressure on rainforest environments in addition to those imposed by other human activities such as selective logging, small-scale farming, and hunting (Malhi et al., 2013). High deforestation rates for cattle ranching and soybean cultivation in the Amazonas region, and palm oil plantations in Southeast and South Asia along with fragmentation and degradation pose further major threats to tropical rainforests



Figure 1. The global distribution of tropical and temperate rainforests in the world (source: Koistinen, 2007).

(Hansen et al., 2015). Apart from that, climate change constitutes one of the most pressing issues leading to increased mean annual temperatures and reduced annual rainfall (Turton et al., 2010). These environmental changes affect biomass, net primary production, and extent and distribution of the rainforest biome leading to the replacement by other ecosystems such as savannahs and grasslands (Becken & Hay, 2007; Lyra et al., 2017). This has also been referred to as the ‘dieback’ of rainforests (Malhi et al., 2009).

To minimise impacts from tourism activities, sustainable forms of nature-based tourism were introduced in rainforests (Gwee et al., 2019). However there seems to be a lack of direction and clarity on established knowledge of rainforest tourism. A better understanding is vital especially for places where new tourism activities are developed without a proper management framework and research, as is the case in many developing countries that depend on income from nature-based tourism (e.g. Thailand, Malaysia and Nepal) (Kim et al., 2019; Kuenzi & McNeely, 2008; Musa, 2002).

Here we present a call for a research agenda for sustainable rainforest tourism. A systematic quantitative review of all rainforest tourism research was undertaken to identify research themes and gaps in order to provide a snapshot of the field and recommend future research areas. Our main focus was on what has been researched about visitors, their impacts and management, along with issues relating to local communities and other stakeholders on nature-based tourism in rainforests across the world. In this review, research articles on impacts of rainforest tourism were considered globally, thus pertaining to various types of rainforest (e.g. tropical and temperate), and therefore generally referred to as ‘rainforests’ throughout. The specific aims of this review were to: (1) identify the timing, the geographic bias of the research, and the subject focus of journals in which this research was published; (2) understand the

subject focus in the four realms of conservation and management, visitor-related research, impacts, and community and stakeholder research; (3) develop a conceptual model to illustrate the current focus of research as a means to present a future research agenda.

Methods

The present investigation employed a systematic quantitative literature review methodology and as part of that a database was developed to collate articles and code specific themes such as for instance the types of tourism impacts studied (Pickering et al., 2018; Sumanapala & Wolf, 2019). Pickering and Byrne (2014) concluded that a systematic quantitative literature review is an effective method to identify the research gaps in a study field based on existing academic literature. We searched online databases (Google Scholar, Web of Science, Scopus) for English peer-reviewed journal publications based on the following keywords and combinations thereof: ‘rainforest’, ‘recreational’, ‘tourism’, ‘tropical forest’, ‘temperate rainforest’ ‘ecotourism’, ‘sustainable tourism’, and ‘forest’. We reviewed reference lists of identified articles for further publications. There are mainly two types of rainforest (e.g. tropical and temperate) across the world (Pearce, 2008), therefore hereafter we refer to the various types of rainforest simply as ‘rainforest’.

This investigation was conducted in four stages according to the Preferred Reporting Items for Systematic Review Recommendations (PRISMA), which included the identification, screening, eligibility, and inclusion of articles. In the first (identification) stage, we searched the above-stated online databases and sourced 675 articles using the described keyword search. In the second (screening) stage, we narrowed our results down to empirical research articles published in peer-reviewed academic journals and excluded book chapters, conference proceedings, theses, non-peer-reviewed

articles, reports and other grey literature due to the difficulty of access to some of this information. In the third (eligibility) stage we scanned and excluded further articles, which did not align with the objective of our study based on the content of the abstract and the conclusions. Finally, in the eligibility stage we included (n = 121) articles for the next stage of the selection process. In the final stage, each document was carefully read and included if it provided the following information: author(s), year of the publication, study location (country, name of the rainforest), and the theme of the study. Finally, after considering all the inclusion criteria, we selected 48 publications (see Appendix 1).

We focussed on peer-reviewed journal publications to ensure a high standard of review, and because of the broader access and reproducibility of our findings. However we followed Pickering and Byrne's (2014) suggestion to refer to other types of publications, specifically two book chapters and a book (Pearce, 2008; Prideaux, 2014a, b), that added particular value to the Discussion. Also, we reviewed the journal publications considering Pearce's (2008) conceptualisation of the main elements of rainforest tourism with a focus on visitor-related factors, impacts, their management/conservation measures, and issues relating to local communities and other stakeholders due to rainforest tourism activities. We were also open to adding new main elements/themes had they emerged in our review; this however was not the case. Because of the impact of climate change as one of the largest dangers faced by rainforests we also included this element in the conceptual model. We had identified/coded frequently occurring subcategories in each main element/theme.

Results

Year of publication

The selected 48 studies on rainforest tourism were published between 1975–2019 and revealed a growing number of publications over time (Figure 2). The number of publications doubled after the year 2000. Notably in 2010, the *Worldwide Hospitality and Tourism Themes* published a special issue dedicated to rainforests, which also included tourism-focused publications. As a result, 20% of the publications we reviewed out of the 48 publications originated in 2010.

Journal subject focus

Rainforest tourism research has been published in 32 different journals across different genres (Figure 3).

Almost half of the studies (43%) were published in tourism-related journals such as the *Worldwide Hospitality and Tourism Themes* (20%), and *Journal of Ecotourism* (8.3%). Most of the other studies (31%) were published in environmental science and conservation journals, such as *Environmental Conservation*, followed by geography journals and those focused on social/natural resources (12%), or other themes (12%).

Methodological approaches

To provide insights into the methodological approaches, we classified the methodology applied in rainforest tourism studies as follows: (1) social versus environmental science, or a 'mix' of the two; (2) qualitative versus quantitative, or a 'hybrid' of the two (Table 1). A study was classified as being 'qualitative' if it applied commentaries, observations, and expert opinions, while the term 'quantitative' was used for experimental research. A combination of qualitative and quantitative approaches was deemed to be a 'hybrid' study according to Tsang and Hsu (2011).

Geographic distribution

Half of the studies focused on South American rainforests, led by Brazilian (18.7%) and Peruvian studies (12.5%) (Table 2). The second main group of studies was undertaken in Australia and Oceania (27%); in particular Australia (25%) that also constitutes the only country that achieved double figures in rainforest tourism studies that originated from the Wet Tropics World Heritage Area; including the Daintree rainforest region near the northern end of the Wet Tropics World Heritage Area. In the early period (between 1980–1990), Asian countries like Malaysia and Indonesia conducted some investigations. Generally though Asian studies as well as African and North American studies are limited. The key studied rainforest locations are presented in Figure 4.

Subject focus of research

Figure 5 presents a conceptual model that we have developed of the main elements of rainforest tourism research as covered in the articles selected for review. We have adopted Pearce's (2008) evaluation of the rainforest system as a base for our assessment. However we have more clearly focused on particular key elements of the rainforest system that appear most essential for an investigation: the visitor, their impacts, the 'surrounding' stakeholder/community situation, and conservation/management efforts taken to address impacts. The

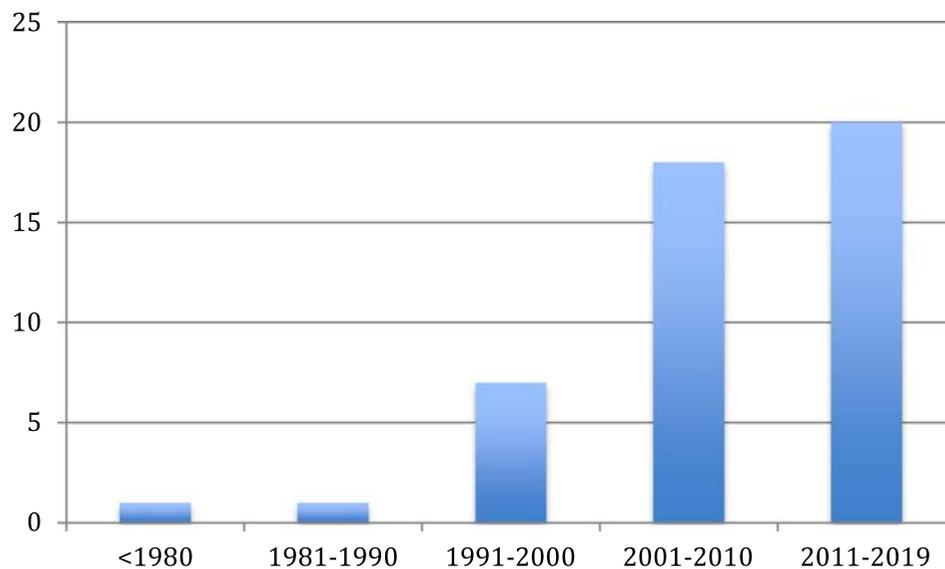


Figure 2. Number of peer-reviewed English journal publications on rainforest tourism.

majority of studies that we reviewed addressed conservation and management topics (33), followed by visitor-related research (23), impacts (10), and finally community and stakeholder research (3).

The largest research area, conservation and management research, has focused on policy studies, planning, education (e.g. tour guiding, interpretation activities/facilities), and conservation topics (e.g. short and long term challenges for conservation, agenda and recovery of the impact) with the latter three requiring more attention in the future given their relatively low numbers.

Community and stakeholder perspectives were largely ignored in rainforest tourism research although

they arguably constitute an important dimension. This is particularly surprising given the varied challenges known to exist between the local community and stakeholders in relation to rainforest tourism management (Scott et al., 2014). Most of the local communities harvest rainforest resources to sustain their livelihoods including through illegal logging and clearing of land for commercial plantations while offering rainforest tourism activities. As a result, many countries have endeavoured to introduce sustainable tourism ventures (e.g. the Paraty Green Map Project in Brazil, and several ecotourism development projects in Southern Chile). Yet these ventures and involved stakeholders remain

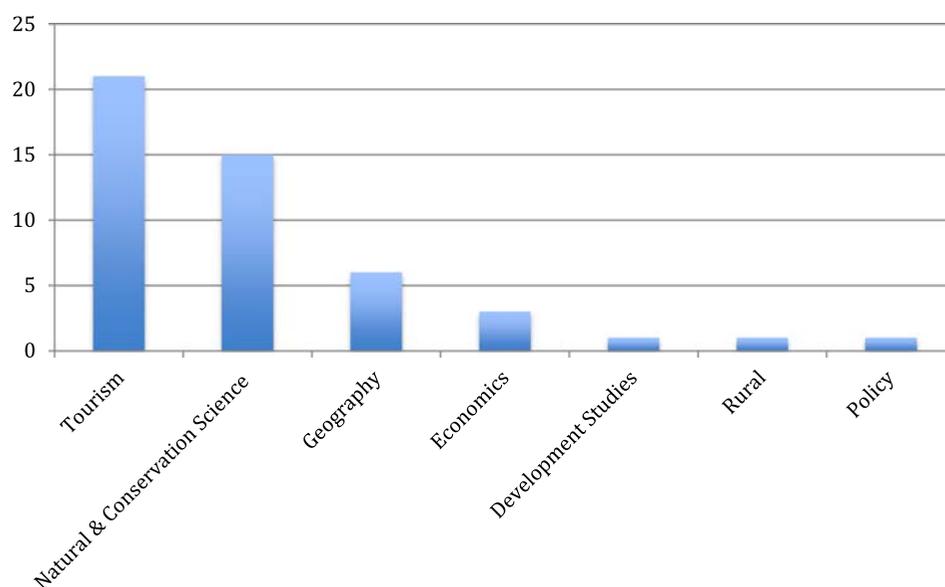


Figure 3. Number of rainforest tourism (peer-reviewed English journal) publications and the specific subject focus of the journals in which they were published.

Table 1. Methodology applied in rainforest tourism studies.

Field of Science	Studies (n)	Studies (%)
Social Science	21	44
Environmental Science	10	21
Mix of Environmental and Social Science	17	35
<i>Methodology</i>		
Qualitative	25	52
Quantitative	16	33
Hybrid qualitative and quantitative research	7	15

unresearched. Similarly, research is lacking on the participation, planning, and management of rainforest tourism through the local community and stakeholders.

An emerging area in rainforest research that warrants further attention in the future is visitor research and their impacts which reflects the increasing demand for rainforest tourism and the related (positive and negative) environmental, social, or economic impacts.

In addition to that, the study on visitors especially their experience and satisfaction with rainforest tourism activities and services are important fields for future research although this type of research has at least received some attention. In contrast identifying motivations to participate and willingness to pay remain understudied. The sustainability of the rainforest industry depends on both the resources and the customer experience. Therefore, basic information on socio-demographic data and trip characteristics of rainforest tourists is required in addition to environmental data. As per our review, data were presented in existing rainforest tourism research on the country of origin ($n = 8$), travel group type ($n = 6$), activities ($n = 5$) and the type of rainforests ($n = 20$) they visit. Data regarding visitors' duration of stay were mainly unclear and difficult to infer in any of the publications. The results for this are shown in Table 3. Accordingly the majority of visitors originate from Australia and North America, travel as couple or friends, and mainly engage in walking, viewing wildlife, hiking, viewing scenery, photography

Table 2. Studies performed on rainforest tourism by region and country.

Region	Country	Number of studies	%age
Africa	Zimbabwe	2	4.6%
	Guyana	2	4.0%
Asia	Malaysia	3	6.2%
	Indonesia	1	2.0%
	Sri Lanka	1	2.0%
Australia & Oceania	Australia	12	25.0%
	Fiji	1	2.0%
North America	Canada	1	2.0%
South/Central America	Brazil	9	18.7%
	Peru	6	12.5%
	Costa Rica	4	8.3%
	Panama	2	4.6%
	Ecuador	2	4.6%
	Bolivia	1	2.0%
	Suriname	1	2.0%

and camping in rainforests. Overall, there is however a clear lack of research using secondary data to track rainforest visitor data across the globe.

Discussion

The study identified 48 articles through a systematic quantitative literature review relating to rainforest tourism with a distinct geographic bias in the research. Although Australia represents only 3% of the total rainforest areas in the world it conducted more studies than any other country (Table 2). Most of these studies were focused on the Wet Tropics World Heritage (WTWH) Area. In contrast, studies on tourism in the Amazon rainforest, the largest rainforest area worldwide, extending across countries such as Guyana, Ecuador, Suriname, Bolivia, and Belize were limited, with the notable exception of Brazil. Research thus needs to urgently expand into the under-represented countries of this significant rainforest region. Similarly, studies are needed in South and East Asia. Asian countries have been promoted as top destinations for rainforest tourism but research has only been conducted in a few countries like Sri Lanka, Malaysia, and Indonesia. Although Pearce concluded in 2008 that more studies are needed on tourism activities in rainforests in Asia, not much has been conducted since. In most of the countries with tropical rainforest the tourism industry plays a major role in income generation in the country. A prime example for that is Costa Rica. Therefore, those countries have to carefully plan for rainforest tourism following sensible guidelines to sustain the industry (Hill et al., 2007a; Prideaux, 2014a). In the following we will discuss the research gaps that need to be addressed in order to underpin the sustainable development of rainforest tourism.

'The visitor' in rainforest tourism research

A considerable number of studies were conducted to investigate rainforest tourism activities through the lens of the visitor. A particular focus was on studies addressing the visitor experience and satisfaction with rainforest tourism. Zhou (2018) found that higher visitor satisfaction triggered repeat visitation and word-of-mouth recommendation. This outcome was achieved by enhancing the image of the destination and offering a broader spectrum of activities to appeal to a wider market (Hill & Gough, 2014); and further, by increasing service quality, value for money, the presence and efficiency of staff, and the availability of visitor information at sites. These findings are informative for the development of rainforest tourism-based experiences. Karp and Guevara (2011) and Campos et al. (2014)



Figure 4. Key areas for rainforest tourism research (the size of the dots reflects the number of papers).

noted for instance that research-providing feedback on offered experiences is necessary to increase use of accommodation (e.g. ‘eco-lodges’ and ‘ecotourism’) in or around tropical rainforests in Peru and temperate rainforests in Chile, respectively. Although some issues impacting satisfaction were noted (Prideaux, 2014b; Zhou, 2018), generally rainforest tourism experiences,

services and facilities seem to be highly satisfying. For example, visitors of the information centre at the Skyrail Rainforest Cableway in Queensland in the tropical rainforest of Australia found that people were highly satisfied with the interpretive facilities on offer (Hill & Gough, 2014; Moscardo & Woods, 1998). Hughes and Morrison-Saunders (2002) found that visitor knowledge

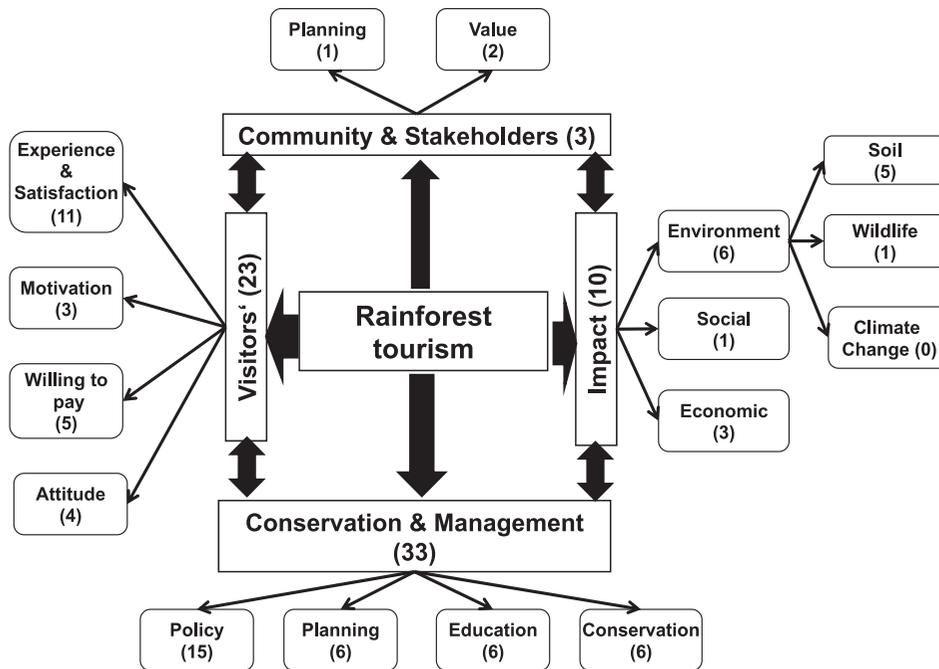


Figure 5. Conceptual model of rainforest tourism and number of research papers (in parentheses) covering each research area. Note: Some papers have covered multiple subjects and therefore the total number of articles listed by research focus exceeds the number of reviewed articles.

Table 3. Number of articles studying particular visitor variables of the 23 rainforest tourism papers that addressed visitor-related subjects.

*Demographic variable	Number of studies	%age
Country of the origin	8	34.7%
Travel group type	6	26.0%
**Duration of stay/amount of days	–	–
Activities	5	21.7%
Type of rainforests	20	87.0%

*Demographic variables available in Visitors' related research in Figure 5.

**Unclear data.

could even be improved by the trail-side signboard at the giants tree top walk in a temperate rainforest in Western Australia. Researching a variety of suitable methods for educating rainforest visitors is needed in the future to maximise visitor satisfaction and to minimise the environmental impacts of tourism activities. As a result of the generally high satisfaction of visitors with the experiences, services and facilities provided in rainforests, willingness to pay more for participating in rainforest tourism activities was great (Reynisdottir et al., 2008). Such findings are important to rainforest tourism destinations especially in developing countries where satisfaction and related willingness to pay needs to be maximised using limited financial means. Consequently, understanding the factors that maximise satisfaction is important (Castellanos-Verdugo et al., 2016).

Future research relating to rainforest tourists should be expanded across geographical areas, and cover various spatial scales ranging from regional to international (Moscardo, 2004) to better understand visitor behaviour (Maoz, 2004), motivations, visitor origins (Yagi, 2004), and visitor satisfaction (McCarthy, 2000), along with their perceptions of tourism in rainforest areas. In addition future studies need to collect socio-demographic information of tourists, market segmentation by activity type and type of forest, and assess how tourists use and value rainforests (Derek et al., 2019). As we saw from our review the market of rainforest tourists is still not well understood with basic information on socio-demographics data and trip characteristics of rainforest tourists often missing. The studies that contained information on demographics and trip characteristics showed for instance that travellers originated from Australia and North America, travelled as couple or friends, and 80% of papers reported on visitation to tropical versus temperate rainforests. Visitors engaged for example in the following activities: walking, viewing wildlife & scenery, hiking, and relaxation.

A notable exception is Pearce (2008) who provides a detailed account of how a rainforest tourism market can be analysed using the Wet Tropics World Heritage area as an example. In that case, a concerted effort

was made drawing from 10 years of research experience in the area and using an array of datasets to better understand the tourism market. Specifically, they evaluated insights using secondary data from assessments of the overall holiday market to Queensland, Australia, along with individual research papers pertaining to the analysis of specific holiday market segments (e.g. backpacker behaviour; studies of different nationalities of travellers). From the six groups that form part of the Queensland holiday market, two groups were most likely to engage with the Wet Tropics: an older demographic who was mainly touring Australia ('senior self-drive market'), and a younger international demographic using budget accommodation or who used local resorts. While this information is relevant particularly to the Wet Tropics (at the time) rather than for other rainforest regions worldwide, important conclusions can be drawn. Firstly, an analysis of the rainforest tourism market is likely to require a locally specific assessment, and only if a range of these assessments were available can a broader meta-analysis be attempted. Secondly, an in-depth analysis most likely requires drawing from a range of data, for example, those generated by state tourism organisations on the respective traveller market along with research studies on particular groups within that market, which should then provide a holistic analysis of the market. Thirdly, the effort involved for such a market analysis may be considerable given how many sources need to be consulted with. Finally, these type of analyses need to be repeated on a regular basis as the traveller market is dynamic and results ultimately represent a snapshot in time. Nonetheless, this study presents an excellent example of how well a rainforest tourism market can be analysed and the insights drawn from such an assessment. Globally, such assessments are clearly lacking and not many rainforest areas are as well researched as the Wet Tropics. Thus, this certainly remains a challenge for rainforest regions in the future that will need to be addressed. Research on visitor monitoring is serious, as without establishing protocols and a better understanding for how to monitor visitors and their numbers, related research such as on impacts and their management are impeded (Sumanapala & Wolf, 2019; Wolf et al., 2018, 2019).

The benefits of nature-based tourism activities are varied and can range from a transient experience of satisfaction with the experience to transformational changes (Saikim & Prideaux, 2014; Wolf et al., 2015, 2017). Conveying such benefits is vital as it may encourage visitor behaviour and builds a constituency for rainforests (Torland et al., 2015; Weiler et al., 2017). Consequently, future research on visitor satisfaction

should hone in on the provision of information, infrastructure development, visitor regulations and management measures (Kaffashi et al., 2015; Loomis & Santiago, 2013). Notably, Makoni and Chikobvu (2018b) highlighted that satisfaction is achieved differently in adults and children as their needs for accommodation, services and activities on site vary considerably, thus socio-demographics need to be incorporated into the research design in future.

Impacts relating to rainforest tourism

Social and ecological impact studies were rather limited compared to visitor and management studies. Rainforest tourism however has the potential to create ecological impacts due to recreational activities taking place in ecologically sensitive environments and the high annual rainfalls, along with new businesses being established in ever more pristine locations. Hill et al. (2007b) highlighted environmental impacts due to recreational activities in rainforests, such as losing species, pollution and noise to the environment, change of animal behaviour, and massive quantities of waste generation in the tropical rainforest (e.g. Daintree rainforest in Queensland, Australia) (Worboys & Gadek, 2004). Hill and his team further explained that soil erosion was five times higher in tourism rainforest areas compared to elsewhere in Costa Rica. Studying wildlife impacts along travel corridors such as road and hiking trails or around viewing platforms is important. Griffiths and Van Schaik (1993) for instance found that wildlife impacts were reported due to human traffic in a Sumatran rainforest. Musinguzi et al. (2014) explained that there were limited studies on the challenges faced by wildlife and future opportunities in rainforest tourism (e.g. primate tourism in Uganda). The creation of informal trails and impacts on both wildlife and vegetation warrants future attention through longitudinal studies and regular monitoring (Griffiths & Van Schaik, 1993).

Previous studies have noted that the spreading of invasive species by humans threatens tourism and the environment in protected areas (Wolf & Croft, 2014). Talbot et al. (2003) concluded that rainforest environments are particularly sensitive due to the high annual rainfalls, moisture retention, and fragility of soils. For example, the study found that soil erosion was five times higher on trails in a Costa Rican rainforest compared to off-trail sites in tropical rainforests. However, thus far research is very limited (Koichi et al., 2012; Tu, 2009). Such impacts are likely to affect the sustainability of a tourism destination as the quality of the environment directly affects visitor satisfaction and therefore the tourism income of the local community (Hull et al.,

2001). Rainforest tourism can be very important to local communities. Especially, some indigenous people may depend on rainforest tourism where they are directly involved.

Griffiths and Van Schaik (1993) also noted ecological impacts of rainforest tourism but argued that the relationship between ecological changes and visitor numbers in rainforest is yet to be identified, a gap, which has not been addressed to date. In fact this is a gap that has been noted for ecological impacts of tourism in general as such studies are quite limited (Wolf et al., 2012). Establishing functional relationships between visitor number and effects is fundamental, and so are the management tools that mediate this relationship.

Turton and Stork (2008) concluded that studies on the impact of tourism and recreation on the rainforest biome are limited. This apparently has not changed since we only identified 10 studies. Given the vast global expansion of rainforests and their biodiversity, it is astonishing that virtually no research has been conducted to address this gap. It should certainly play a major role in future studies, possibly with an initial focus on key species attracting visitor attention, then shifting to the more cryptic species that may also be affected by tourism. This is warranted because although many studies are available that document ecological impacts of tourism (e.g. Barros et al., 2015; Buckeley, 2003; Wolf et al., 2013; Wolf & Croft, 2010, 2012, 2014), negative effects may vary according to the ecosystem and the actual tourism activity.

In the context of environmental concerns, climate change poses a critical threat to the rainforest biome (Prideaux, 2014a), as it does elsewhere for many different ecology systems (Sheldon, 2019). In a fragile rainforest system the effects of climate change may be particularly pronounced such as a change in the biodiversity and functioning, and in the composition of biological communities and species distributions (Colares et al., 2021). Globally, the tourism industry generates a considerable amount of greenhouse gas emissions (Scott & Becken, 2010) with steep increases predicted over the next decade (Zeppel, 2014). Many studies in fact exist on the environmental effects of climate change such as on insects (e.g. Colares et al., 2021; Miao et al., 2020), amphibians (e.g. Dubos et al., 2020), and trees (e.g. Russell & Parton, 2020). Some of these studies also show how climate change impacts on rainforest fauna and flora (e.g. Hoffmann et al., 2018; Smith et al., 2021). However, little is known about the effects of climate change on rainforest tourism or the combined effects of rainforest tourism and climate change on the rainforest biome, which requires long-term study

(Aleixo et al., 2019). In particular it would be of interest to see how climate change might exacerbate or alter some of the impacts of rainforest tourism on the environment. For example, changes in climate may impact on tourism destinations, their attractiveness and consequently use. It may also impact on their resilience to other disturbances brought on by tourism activity. This will be an interesting field of study in the future (Turton, 2014).

Further, almost no research has been conducted on the social impacts of rainforest tourism. Our review found that tourism development can have negative consequences through social impact (Diedrich & Aswani, 2016). Although some research exists that has focused on investigating potential socio-cultural changes due to tourism development and how to best plan in order to attain positive effects of rainforest tourism for local development (Aswani et al., 2015). There is also no research on visitor perceptions of environmental impacts and how they influence visitor satisfaction with the experience (Monz et al., 2010). In the future a focus needs to be on visitor-created socio-cultural impacts (Pearce, 2008), for example, to understand such impacts in the emerging Asian markets relating to Chinese outbound visitors (Sumanapala et al., 2017) and also to discuss the economic impacts.

Conservation and management of rainforest tourism

The main area of research on rainforest tourism constitutes conservation and management, in particular education of visitors (Figure 5). Tour guides were thought to play a prominent role in conveying conservation messages and delivering a satisfying visitor experience in rainforest tourism to contribute towards a sustainable form of rainforest tourism (Koichi et al., 2014). Apart from that not much research has focussed on tour guides, and there is certainly potential to develop this research further especially where it relates to conveying environmental conservation messages and fostering low-impact visitor behaviour. The performance of tour guides at visitor centres and during tours is essential for the future development of the rainforest tourism industry. Further, McNamara and Prideaux (2010) highlighted the importance of providing interpretation facilities and activities for conveying conservation messaging which warrants a more detailed future investigation.

The management authorities need to develop rigorous and fair policies to design and implement sustainable tourism in tropical rainforests (Jesus De, 2010). In the future research is also needed on decision making around the management and conservation challenges imposed by rainforest tourism. Geographic Information

Systems can aid in this process for both monitoring visitor usage as well as impacts such as informal trail mapping. In addition to that, future research should explore international and local visitor forecasting to plan for demand (Divino & McAleer, 2009). Future research can help with identifying priority areas for conservation (Margules & Pressey, 2000) using tools such as C-plan, TARGET, MARXAN to aid in the decision-making (Possingham et al., 2000).

Finally, using innovative spatial tools for rainforest research by adopting GIS technology can help park managers identify and map for instance visitor flows and impacts such informal trail development. Managers can use these data to plan for zoning of rainforest areas.

'Community and stakeholder' studies in rainforest tourism research

Researching the involvement of local communities/indigenous people in rainforest tourism provides a whole new field for research. Mostly community and stakeholder studies were very limited in rainforest tourism research, which is a major oversight in the field. From a management point of view, we need to identify the management issues, as they are complex and not addressed in research from the community point of view. This entails issues on land use policies in rainforests, particularly in developing countries, including around forest boundaries. Involving and empowering local communities should be at the forefront of managing rainforest tourism (Butts & Sukhdeo-Singh, 2010). Sustainability of rainforest tourism not only depends on an intact ecology but also on a functioning local community surrounding rainforest areas, and should therefore be at the core of any sustainability debate and future research agenda. Especially the complexities arising from rainforest tourism and involvement of indigenous people attached to rainforest areas such as the Gondwana Rainforests or Australian Aboriginal heritage areas will undoubtedly yield critical insights for management of tourism within these sensitive areas (Wilson et al., 2011).

We therefore recommend the planning, monitoring and collective work of stakeholders in the industry (local community, relevant authorities and tour operators) as three main study areas in the future. Rainforest tourism is generating revenue for the local community and tour operators. However, issues may arise such as unevenly shared financial benefits, stakeholder conflicts or non-acceptance of management measures to address environmental impacts. Empowerment of local communities particularly indigenous people is one of the most effective ways to transfer knowledge

from the community and aid in local decision making around rainforest tourism issues (Farrelly, 2011). Therefore, Mendoza-Ramos and Prideaux (2014) concluded that future studies are needed to identify effective empowerment strategies to maximise the indigenous community involvement in rainforest tourism with the help of government and the private sector (Guaigu, 2014; Mendoza-Ramos & Prideaux, 2017). When local communities strongly depend on rainforest tourism, their incentive is strong to collaborate on research with relevant authorities on how to deploy their skills in different areas such as visitor education and environmental conservation strategies (Hill & Hill, 2011).

Conclusions

Rainforest tourism sustains in many countries worldwide the livelihood of local communities who deliver services such as accommodation, interpretation, park management, and the provision of activities. At the same time, this industry is expanding into ever more remote locations adding to pressures from other human activities to this exceptionally important and fragile ecosystem. Yet compared to other ecosystems, research on tourism in rainforests is rather sparse especially compared to various fields of rainforest studies. Our study has identified current knowledge and gaps, and established an agenda for future research relating to visitors, impacts, management and local communities of rainforest biomes.

This information was integrated in a new conceptual model that highlights that future research should expand into the social and environmental realms of recreational impacts on rainforest biomes. Importantly in this context, long-term impacts of climate change need to be assessed as they exacerbate impacts from rainforest tourism or alter the behaviour and spatio-temporal distributions of visitors. In addition to that the planning and management of rainforests from a community and stakeholder perspective deserves attention in future studies. Importantly, demographic information needs to be collected on rainforest visitors, their activities, and duration of stay or expended time, needs, preferences and behaviours to better understand the market situation. Although existing rainforest research has presented some information on socio-demographic data and trip characteristics of rainforest tourists, much greater insights are needed and possibly an in-depth market analysis undertaken using secondary data although the challenge will be that these sort of data are likely to vary considerably by country. Also, a distinction may need to be made between recreational and tourism activities as impacts may vary, for example,

because of the engagement with different activities and frequency and location of visitation. Given the sheer size and global expanse of the rainforest biome, research may need to seed from auditing/monitoring of specific rainforest tourism ventures and establish as to whether and how these individual ventures meet sustainability requirements both socially and environmentally (Doan, 2013; Fennell, 1999; McLaren, 1998). Such singular studies may then be meta-analysed to draw more general conclusions. Although our study focused on rainforest tourism, this field of research will benefit from an inter-disciplinary approach; there is a crossover between tourism research and a range of sciences that are interested in various aspects of tourism use of rainforests such as ecology (Stork et al., 2008).

As most rainforests are located in developing countries, researchers may have faced limited funding for research and lack of expertise in the field (Monz et al., 2010; Newsome et al., 2013; Sumanapala & Wolf, 2019). Rainforest tourism has the great potential to be developed as responsible travel to an ecologically sensitive environment while conserving the environment and improving the local community's wellbeing. This requires the establishment of protocols, which in turn are reliant upon a solid research foundation. Future research on rainforest tourism needs to expand its methodological scope towards innovative and mixed approaches (e.g. modelling, use of drone cameras) to monitor tourism impacts.

A few limitations of this study should be noted: This review was limited to peer-reviewed articles published in English language journals. This study did not analyse social media (e.g. blogs, micro-blogs, Facebook, and Twitter). Zeng and Gerritsen (2014) noted that social media have played a significant role in the tourism industry especially in emerging research for gathering information about tourist demographics, their feedback, and challenges experienced. This would a valuable avenue to explore in future research. Expanding the review to non-English literature and social media may also provide further insights especially considering that most of the rainforests are located in non-English speaking countries.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix 1. Author(s), year and Journal publication included in this study

Authors (year)	Journal
Aiken and Moss (1975)	<i>Biological Conservation</i>
Aihara et al. (2016)	<i>Journal of Tropical Forest Science</i>
Buckley (2017)	<i>Journal of Travel Research</i>
Butts and Sukhdeo-singh (2010)	<i>Worldwide Hospitality and Tourism Themes</i>
Boucher (1991)	<i>Environmental Management</i>
Comita and Goldsmith (2008)	<i>Biotropica</i>
Cotez (2010)	<i>Worldwide Hospitality and Tourism Themes</i>
Divino and McAleer (2009)	<i>Environmental Modelling & Software</i>
Doan (2013)	<i>International journal of tourism Research</i>
Francis et al. (2019)	<i>Tourism Review</i>
Green and Green (2013)	<i>Journal of Hospitality & Tourism Education</i>
Griffiths and Van-schaik (1993)	<i>Conservation Biology</i>
Gwee et al. (2019)	<i>Journal of Sustainable forestry</i>
Hill and Hill (2011)	<i>Geography</i>
Hill et al (2007a)	<i>Journal of Ecotourism</i>
Hill et al. (2007b)	<i>Geography Review</i>
Hoeft (2016)	<i>Journal of Rural studies</i>
Honey et al. (2016)	<i>Journal of Ecotourism</i>
Jayawardena and Sinclair (2010)	<i>Worldwide Hospitality and Tourism Themes</i>
Jesus (2010)	<i>Worldwide Hospitality and Tourism Themes</i>
Jusoff (1989)	<i>Environmental Conservation</i>
Karp and Guevara (2011)	<i>Biotropica</i>
Kirkby et al. (2011)	<i>Environmental Conservation</i>
Koichi et al. (2012)	<i>Journal of Ecotourism</i>
Kull et al. (2007)	<i>Society and Natural Resources</i>
Makoni and Chikobvu (2018)	<i>Southern African Business Review</i>
Makoni and Chikobvu (2018b)	<i>African Journal of Hospitality, Tourism and Leisure</i>
McAlpin (2008)	<i>Policy Sciences</i>
McNamara and Prideaux (2010)	<i>Environmental Education Research</i>
McNamara and Prideaux (2011)	<i>Asia Pacific Journal of Tourism Research</i>
Menkhaus and Lober (1996)	<i>Journal of Environmental Management</i>
Mercer et al. (1995)	<i>Journal of forest economics</i>
Pereira and Mykletun (2012)	<i>Scandinavian Journal of Hospitality and Tourism</i>
Prideaux et al. (2012)	<i>Journal of Ecotourism</i>
Ramos and Prideaux (2014)	<i>Journal of Sustainable Tourism</i>
Reyes (2010)	<i>Worldwide Hospitality and Tourism Themes</i>
Sijlbing (2010)	<i>Worldwide Hospitality and Tourism Themes</i>
Sinclair and Jayawardena (2010)	<i>Worldwide Hospitality and Tourism Themes</i>
Tobias and Mendelsohn (1991)	<i>AMBIO</i>
Talbot et al. (2003)	<i>Journal of Environmental Management</i>
Turton (2005)	<i>Geographical Research</i>
Weaver (1993)	<i>Journal of Pacific Studies</i>
Wearing and Parsonson (2001)	<i>Tourism management</i>
Wearing (1993)	<i>The Environmentalist</i>
Wilson (2011)	<i>Journal of Heritage Tourism</i>
Yanez and Sevilla (2010)	<i>Worldwide Hospitality and Tourism Themes</i>
Yu et al. (1997)	<i>Environmental Conservation</i>
Zhou (2018)	<i>African Journal of Hospitality, Tourism and Leisure</i>