

## Can Virtual Reality Become an Instrument in Favor of Territory Economy and Sustainability?

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### Abstract

The study aims to identify how virtual reality technology can help protect and conserve flora and fauna in national parks and other environmental settings. To this end, the literature published in the Scopus database is examined. A Systematic Literature Review methodology from 2018 to 2022 and an Empirical Research (survey) applied to tourism in natural areas, mainly national parks, have been proposed. Virtual reality technology is particularly useful as a complement or alternative to visiting national parks. The main results indicate that, currently, daily life confronts us with stressful situations that can be mitigated through ecotourism, as well as virtual reality applications, such as games and videos, which interactively inform about the species of flora and fauna present in the park visited. This helps in the conservation and protection of endangered species, the conservation of the forest, as well as archaeological heritage sites present in these natural parks. The development and implementation of this technology varies from one context to another. It is beneficial for people with some kind of disability or for the physical effort involved in long walks, even on steep terrain, and sometimes it improves the conditions of access to the national park and the dangers related to such an exciting adventure.

**Key Words:** digital economy, ecotourism, national park, virtual reality, virtuality, nature conservation education

**JEL Classification:** M21, Q2, O33

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### 1. Introduction

The impact of globalization and economic growth has left its mark on ecosystems, and in recent decades it has become more evident how the natural resources for future generations are being compromised, leading to an increase in endangered species of flora and fauna, despite the efforts to improve conditions for biodiversity in general (Guan et al., 2022). Even today we are witnessing the threat that they are experiencing, concentrated largely in national parks or animal rescue centers, through systems of protection and conservation, in a joint effort involving governments, NGOs,

philanthropic organizations and countless volunteers who are fighting to mitigate the damages and reverse this process of deterioration (Rhama & Kusumasari, 2022).

Borders are no longer a problem in an interconnected world where we move around for a variety of reasons, whether business or tourism, leaving an environmental footprint along with problems caused by climate change, which are not unrelated to visits to national parks, rescue centres, or other contexts of interrelation with biodiversity (Lin et al., 2022). Sometimes damage is caused consciously or unconsciously in the conditions of the site and species, which could be due to various reasons such as the group tours that are carried out and can be repeated several times each day (Dieck et al., 2018). The visitor usually keeps the experiences lived in videos or photos that can have a double negative effect. The first one is stepping involuntarily on small insects, frogs or other animals, and the second one is using the flash in the photographs, which can disorient some species, especially in night tours (Jiang et al., 2019).

Sustainability is a term that should be of interest to everyone at a global level. Economic growth and the deterioration of natural resources is growing at alarming rates. It is inconceivable to disassociate our responsibility in this matter (Huang et al., 2022). The use of VR in favour of the economy and sustainability of a territory can be approached within strategic management, as an integral part of corporate governance to improve the competitiveness of enterprises and their stability in domestic and foreign markets (Dvorský et al., 2020).

The main concept and the first one that clearly defines sustainable development was the Report of the World Commission on Environment and Development, better known as the Brundtland Report (BR), endorsed by the United Nations. The BR is forceful in its diagnosis: “We are unanimous in our conviction that the security, well-being, and very survival of the planet depend on such changes, now” (Brundtland & O.N.U., 1988) (p.334) in item 126; this report offers us for the first time, a definition of Sustainable development, indicating that “Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.” (Brundtland & O.N.U., 1988), p.24) in item 27.

In 1992, two important events took place, before the first scientific reports in 1990, which warned about global warming. In search of solutions governments approved in New York, the United Nations Framework Convention on Climate Change, which seeks to stabilize the atmospheric concentrations of greenhouse gases (Harvey, 2007).

Aware of the efforts made by International Organizations and countries to preserve natural resources, as well as technological advances, we have tried to explore one of the options currently available, namely virtual reality, which may be applied to many fields of knowledge, being highly useful in sustainable tourism, ecotourism, conservation, and research activities, developing new and improved applications that allow us to observe closely the majesty of nature every day (Ács et al., 2022).

The objective of this study is to identify through the Systematic Literature Review and an Empirical Research, how virtual reality technology can help in the protection and conservation of the flora and fauna in national parks and other environmental settings. To this end, a review of the scientific literature indexed to Scopus, published in this database until the year 2019 is examined, as well as information related to the National Parks.

The research questions are as follows:

- RQ 1. How virtual reality can be an instrument at the service of sustainability?
- RQ 2. Which advantages of virtual reality are most relevant in the scientific literature?
- RQ 3. What are some of the benefits for parks?
- RQ 4. What do park visitors think of VR and its possibilities?

To achieve this purpose, the following sections review the significant literature on the subject and present the methodology used with the questionnaire and the items. Subsequent sections are devoted to discuss the results and present the conclusions.(Rojas-Sánchez et al., 2022)

## 2. Literature review

The present study considers scientific literature related to our objective of study, which explores the use of virtual reality and its application in the protection and conservation of national parks and biodiversity in general, checking if there are intentional studies that allow to contrast our results in relation to the social benefit, the intention of use of the VR technology and the benefits derived from the use of the applications in national parks. The documents are identified through Scopus, which is the database of bibliographic references and citations of the Elsevier company, considered the largest multidisciplinary database of peer-reviewed literature in social science research (Bartol et al., 2014). The database counts with peer-reviewed scientific literature, providing “a summary of global research production in the fields of science, technology, medicine, social sciences, arts and humanities” (Álvarez-García et al., 2018), p. 5); it counts with more than 22,800 titles, 5000 international publishers and 1.4 billion references cited dating from 1970 (Elsevier, 2020); and it counts with an even larger amount of indexed journals (Martín-Martín et al., 2018). It also includes all SJR journals (Scientific Journal Rankings), JCR journals (Journal Citation Reports) and their impact factors (Cobo et al., 2011).

We take into consideration the above-mentioned information, as well as published articles and reviews available until 2019, regardless of their field of knowledge, but which are published in English. Also, books, editorials, notes, and letters are excluded from this selection process. We have limited the search by considering the “title”, considering “virtual reality” (virtual reality) search terms as key words, which are included between quotes in order to cover all the documents that contain that combination of words in the titles. In addition, the Boolean operator “and” and “or” are used to include the concepts and definitions that may appear in the title, summary or key words, so a search string is used which includes words such as: *sustainab\**, *ecotourism\**, *national park\**, *biodiversity\**, *nature\**, *application\**. In the identification of the documents, the asterisk is included at the end to get the maximum number of possible combinations and endings for that word. The result of the search is 146 documents that are screened to discard those that are not related to the subject of study, and documents compiled that are related to the objective are also included. Finally, 32 relevant documents are considered (see Table 1).

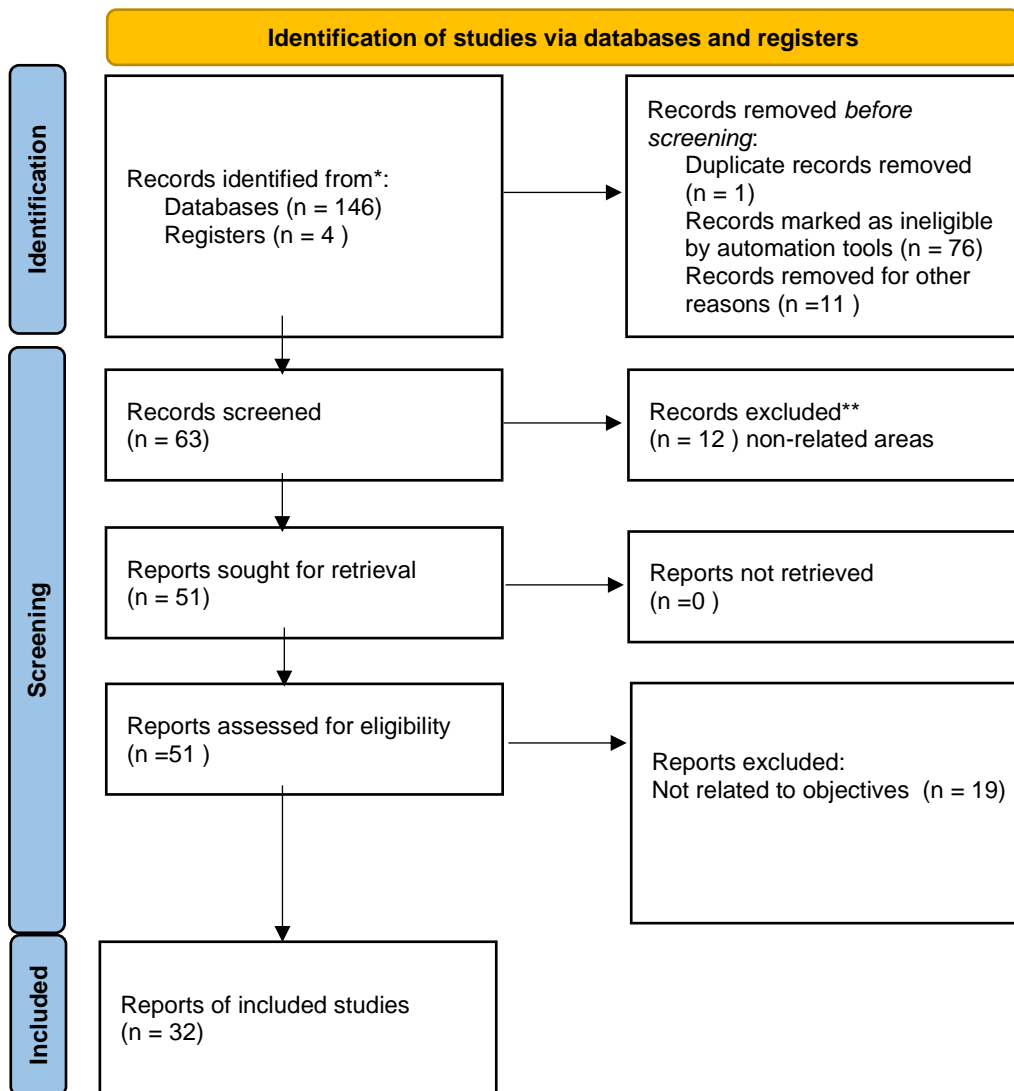
Table 1. Search strategy

Search Word	"Virtual reality", "Ecotourism", "National Park", Nature, biodiversity, Application.
Category Title	Scopus:
Subject Area	All
Document Type	Journal article
Period Time	Year of publication 2018 - 2022
Language	English
Query String	Scopus: (TITLE (sustainab*) OR TITLE (ecotourism*) AND TITLE ("national park*") AND TITLE-ABS-KEY ("virtual reality") OR TITLE-ABS-KEY (nature*) OR TITLE-ABS-KEY (application*) OR TITLE-ABS-KEY (biodiversity*))
Search Date	December 2022

Source: Own elaboration according to Álvarez-García et al.(2018)

Additionally, we have carried out individual research studies to analyze similar experiences in the field of sustainability but associated to topics such as: culture, leisure, fauna, flora, and free time, which include more recent publications. Figure 1 shows the criteria for the selection of Systematic Literature review (SLR) documents.

Figure 1. Prism Selection Criteria



Source: Own elaboration according to Rahman et al. (2022)

### 3. Methods

#### 3.1 Study area

Costa Rica is an equatorial country that located in Central America, is one of the 25 countries with the greatest biodiversity on the planet, where more than 500,000 species live (D.W., 2019), reaching 6% of the world's biodiversity, in an area of 51 100 km<sup>2</sup> of land surface and 589 683 km<sup>2</sup> of sea surface, it counts with wildlife refuges, protected areas, and other forms of conservation, which represent 26% of the territory (Fonafifo, 2019, p.11). It currently has 27 national parks, the National System of Conservation (SINAC) is the institution responsible for the conservation and sustainable use of the country's biodiversity.

The country is characterized by its constant search for conservation and the route to carbon neutrality, as part of a National Plan of Decarbonization (MINAE, 2018)), managing to reduce logging

and increasing its forest cover, counts with parks that have been recognized worldwide, such as the Cocos Island National Park, which was declared a world heritage site by UNESCO in 1997 (WHC, 2020). A recent study on the residence of the White Tip Shark mentions that the Cocos Island Marine Protected Area probably provides effective protection to that shark population for illegal fishing (Lopez-Garro et al., 2020).

The question we ask ourselves is whether VR can mitigate the damage that can be caused by visiting parks and help in the protection and conservation among many other options. In the case of Costa Rica's National Parks, VR could reduce the dumping of containers and garbage on touristic trails and its consequent contamination or due to involuntary running over by drivers, such as skunks, iguanas, raccoons, coatis, among many others, mainly when trying to cross public roads, due to the proximity of nature and nearby communities.

To this end, measures have been implemented, such as: time restrictions, education of visitors so that they know how to behave when faced with a nest and so that they do not disorientate the hatchlings on their journey to the beach, and monitoring of nests. Research has shown that if visitors and neighbours take flash photographs as soon as they emerge from the sea, this can alter the behavior, as well as the number of turtles that come out to lay their eggs, Jacobson & Lopez (1994) indicates that they were observed during their investigation "nesting turtles were observed being disturbed by the use of flashlights and flash cameras, physical blocking or touching of turtles arriving from or returning to the sea" (p.416).

The Annual Statistics Report SEMEC 2021 by SINAC (SINAC, 2021) shows the number of visitors in state Wild Protected Areas (ASP for its acronym in Spanish). According to the Costa Rican Tourism Institute, it indicates that 64.8% of tourists who flew in between 2017 and 2019 performed some type of eco touristic activity, Some of these are: Visit to volcanoes, Flora and fauna observation, Bird watching with equipment, Hanging bridges, Diving, Cable car, Dolphin and whale watching, Snorkelling, Speleology, caverns, Horseback riding or horseback riding. A total of 1,347,055 tourists entered the country in 2021, of these 1,254,369 indicated their reason for travel (vacation, recreation and leisure) and of these 630,468 visited a National Park, not counting other protected areas, which shows the close relationship between tourism and nature protection and conservation activities. Manuel Antonio National Park was the most visited place by tourists. Table 2 shows national and foreign visitors as detailed by ASP.

Table 2. Visitation, residents and tourists by ASP and protection category

ASP Type	Total residents	Total non-residents	Total visitation
National Park	874.125	630.468	1.504.593
Marino Ballena	173.642	61.793	235.435
Irazú Volcano	164.685	28.218	192.903
Manuel Antonio	139.462	190.149	329.611
Volcán Poás	74.877	35.144	110.021
Cahuita	74.074	48.315	122.389
Volcán Tenorio	54.108	69.524	123.632
Tortuguero	40.250	67.513	107.763
Arenal	26.759	42.160	68.919
Santa Rosa	26.209	5.267	31.476
Chirripó	22.863	1.331	24.194
Rincón De La Vieja	19.770	28.008	47.778
Corcovado	14.632	29.502	44.134
Tapantí Cerro	11.121	1.029	12.150
Carara	10.024	8.361	18.385

Las Baulas	5.281	0	5.281
Barra Honda	4.207	977	5.184
Braulio Carrillo	3.396	1.479	4.875
Polo Verde	3.300	1.875	5.175
Isla del Coco	3.140	9.536	12.676
Barbilla	1.123	38	1.161
La Amistad International	974	140	1.114
Piedras Blancas	91	95	186
La Cangreja	82	14	96
Juan Castro Blanco	55	0	55
Diría	0	0	0
<b>Guanacaste</b>	<b>0</b>	<b>0</b>	<b>0</b>

Source: own elaboration

The most recent information on Wild Protected Areas, including the handling category, is found on the website of SINAC in the Costa Rican Protected Areas Control (SINAC, 2022). This information is updated to August 24th, 2020. It shows the number and extension as shown on Table 3.

Table 3. Total ASP by handling category

Handling Category	Number of ASP	Area (Km <sup>2</sup> )	% Terrestrial and Insular protected	% Marine Protected
Handling Marine	4	11 106,31	ND	1,88242
Wetland	12	366,15	0,71639	0,00001
National Monument	1	2,30	0,00449	ND
National Park	29	10 151,52	12,48338	0,63939
Wildlife National	51	2 899,59	4,58933	0,09397
Biological Reserve	8	277,19	0,44065	0,00881
Forest Reserve	9	2 152,60	4,21252	ND
Absolute Natural	2	31,13	0,02828	0,00282
Protecting Area	33	1 545,78	3,02501	ND
Grand Total	149	28 532,47	25.50005	2,62742

Source: SINAC, 2022

Note: Percentages based on a land and island area of 51100 Km<sup>2</sup> and a marine area of approximately 590 000 Km<sup>2</sup>

The website of the Costa Rican Tourism Institute (ICT, 2022) counts with a statistic section which allows the visualization of visitor entrances to the country by different means available: air, sea, land, water. This allows us to see the arrival of tourists for a country with so many options for ecotourism and sustainable tourism, where there is a close relationship with visits to national parks or protected areas.

### 3.2 Survey on Sustainability and Intention to Use VR

What do park visitors think of VR and its possibilities? Initially, it was proposed to carry out semi-structured interviews on site, but the disadvantage of the pandemic arose in the research process, so we took advantage of technological tools to apply an alternative quantitative instrument such as the survey, since "it is an effective means of knowing the behavioural characteristics of the agents involved" (Trespacios et al., 2005, p.96).

We used google forms as a survey management software, sent online to national and foreign tourists over 18 years old, who have used virtual reality applications and visited the National Parks of Costa Rica, for which we established questions that allowed us to discard people who did not meet that profile. The context was selected because we believe that RV has a great potential for the protection and promotion of natural areas and although subjectivity is not discarded, this country has made important advances in the field of sustainability and is heading towards the decarbonization of its economy in the coming years. However, the impact of information and communication technologies (ICT) on national parks and especially on RV is unknown. Although the use of "ICT" is more common in developed countries, we intend to compare the results, although not necessarily comparable, in order to know what park users, think about the possibilities of RV and whether the concern for sustainability influences the intention to use these applications.

Although the use of "ICT" is more common in developed countries and is absolutely incomparable and asymmetrical; countries such as Spain, with greater use of VR in benefits its parks and the species that inhabit them, is a strategy adopted by the competent authorities, certainly allows a balance between visits and conservation or protection of the same.

The Spanish Government is developing a Web Geoportal, which contributes to the planning of possible routes in a project called "National Parks in 3D". The project aims to better manage natural resources and provide visitors with data and tools to make better use of the route (IGN, 2018).

The APP includes information on the history, fauna and flora, routes, viewpoints, services such as accommodation and location, but in its first version of the app only includes four parks: Another example is the visualisation of the ascent to Mount Teide National Park in Virtual Reality through Google Street View, which publishes photographs from 3543 metres to 3708 metres from the crater (Ortiz, 2017).

This study demonstrates the practical benefits of these applications in different contexts with a common benefit of environmental conservation and mitigating the effects of climate change.

### 3.3 Study Population and Sample Selection for the Survey

The resident and non-resident tourists who visited Costa Rica's national parks in 2019 were a total of 2,117,384, mostly North Americans, Central Americans, and Europeans (ICT, 2022). However, 2020 has been an atypical year for health measures to prevent infection by the pandemic, this has involved the closure of airports, therefore, during the fieldwork conducted in June 2020, there was an entry of tourists until May of 874,812 people by all means, considering that 64.8% of visitors perform ecotourism activities (ICT, 2022) we consider that 566,878 non-resident tourists will visit the parks since the updated data is not yet available, we must add the resident tourists who visit the national parks, for the year 2019 represent 75.49% in relation to non-residents, so we estimate at 427,936 resident tourists and a population under study of 994,814 people.

The sample was composed of 455 people who meet the requested profile, is an appropriate size for this study. The sampling used is random or probabilistic, as an instrument of information collection a structured questionnaire, being the information anonymous. Was sent electronically to 1,650 people in the studio population, using databases of companies related to tourism and marketing. All tourists were informed of the purpose of the study, and each was asked to complete the survey.

### 3.4 Questionnaire and Items

This study focused on the existence of interrelations between three constructs: sustainability, social norms that may influence the use of RV technology in natural areas, and the intention of using this technology in national parks or natural areas. All of these are latent variables that cannot be directly measured, so it was necessary to define indicators when creating the questionnaire to evaluate the

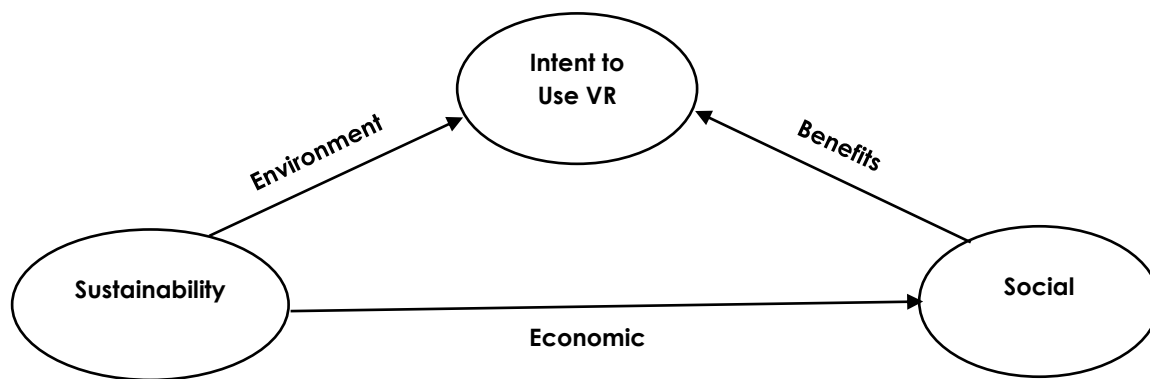
perceptions of tourists of each construct. The definitions of the indicators were based on existing studies. And it was measured using scales previously developed by (Venkatesh et al., 2012; Israel et al., 2019; Ahn et al., 2016).

The questionnaire was divided into two sections, one where demographic characteristics are requested such as: age, gender, nationality or behavioral aspects such as whether you travel alone or with your family, in the second part these three variables are measured, for this four items were used to evaluate aspects related to sustainability and the importance of using or not using applications, in terms of social norms that can influence the decision to use VR applications three items were used, finally to evaluate the intention of using VR technology in national parks or natural areas, four items were used.

To check the relationship in the three defined constructs, responses were given on a five-point Likert scale according to the perceptions of tourists, ranging from 1 ("Strongly disagree") to 2 ("Disagree"), 3 ("Neither agree nor disagree"), 4 ("Agree"), 5 ("Strongly agree").

Figure 2 illustrates the possible relationship that we are interested in seeing between the sustainability construct and the intention to use and whether this causal relationship is presented for social norms and the intention to use.

Figure 2. Model of use VR



Source: own elaboration.

## 4. Results

### 4.1 Summary of VR use in the Costa Rica context

The society has had an increase in its commercial activities in the last decades, in this process economic growth models have been implemented that sometimes had a negative impact on the natural environment; in the case of Costa Rica, it was not the exception, facing problems of illegal hunting, logging, poaching, among others. What makes a difference and makes it an example to follow are its policies in favor of protection and conservation, which are reflected in the increase in forest coverage, the increase in the area of national parks and the creation of new ones, the joint work of non-profit organizations, such as associations of people in favor of adequate management of natural resources. It is a context with a small extension that does not prevent a quarter of it from going to protected wild areas, when today's society has become more urbanized, with increasingly difficult access to nature due to its accelerated life and the stress of traveling on a congested highway to enjoy these natural areas (Levi & Kocher, 1999).

As for the use of virtual reality applications in National Parks, these have increased in recent years, which makes technology an ally for the protection and conservation of endangered species in these places, allowing to enjoy the images and sounds that help living the experience closely. Nowadays,



we can find VR videos about nature, filmed in national parks on the social network Youtube. Recent research has studied the comments to videos on this social network (Palos-Sánchez et al., 2022).

We find examples in the Wildlife Refuge Playa Hermosa - Punta Mala, in Cocos Island, as well as 360-degree videos that have been enabled by the National System of Conservation Areas (SINAC) of Manuel Antonio National Park, Tortuguero National Park and Poás Volcano National Park.

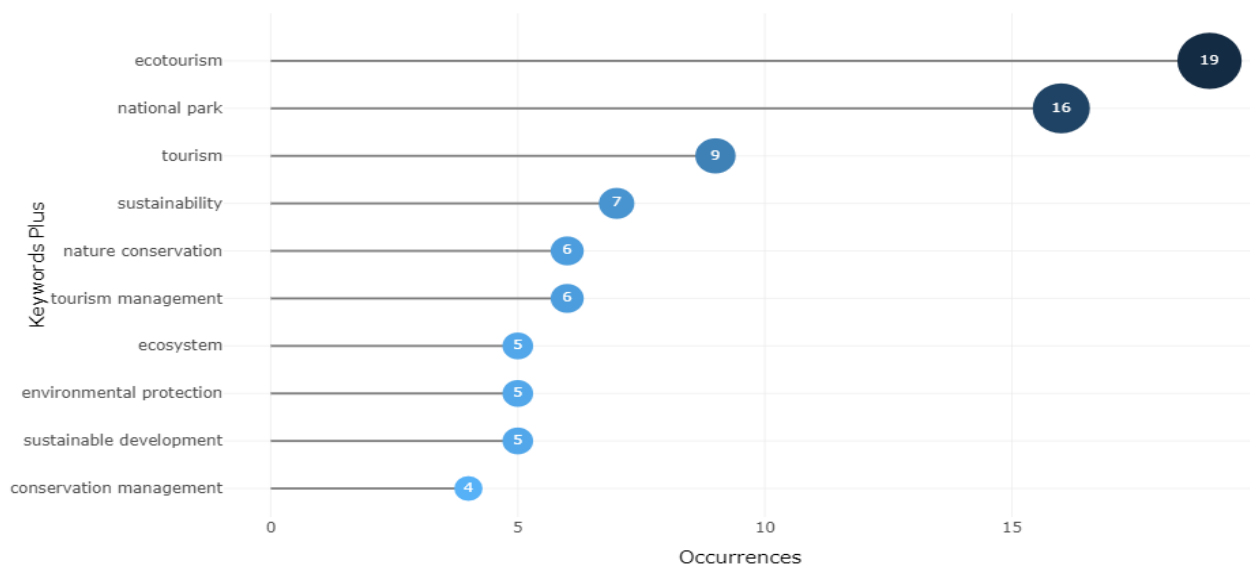
However, we found no evidence of RV use for educational purposes as a voluntary measure or as a means of pre-visit information, that allows the visitor to move around the area and get close to objects or animals that seem interesting (Hurst, 1998). However, there is, in the scientific literature, a lot of research work linking VR with Education (Rojas-Sánchez et al., 2022).

As it has many parks and protected areas, tourist activities are oriented towards sustainable development, with leisure activities, so ecotourism became an alternative to enjoy natural areas, through bird watching, crocodiles, monkeys, hiking, climbing Cerro Chirripó in Chirripó National Park, the highest with 3820 meters above sea level, or perform aquatic activities such as diving or snorkeling. This is in line with Kamri and Radam (2013) who state that leisure visitors are attracted to national parks because they offer innumerable recreational activities ranging from quiet walks to hiking on the trails.

#### 4.2 Systematic Literature Review Summary

When analyzing the 32 documents, we do not see many publications that contribute on the use of virtual reality (VR) in the context of national parks or tourism activities, in figure 3 we see that the main words do not consider this term, this is not considered in the graph because it occupies the 23rd position, the words with the highest occurrence are ecotourism, national parks, tourism, sustainability and nature conservation.

Figure 3. Most frequent words in dataset



Source: own elaboration.

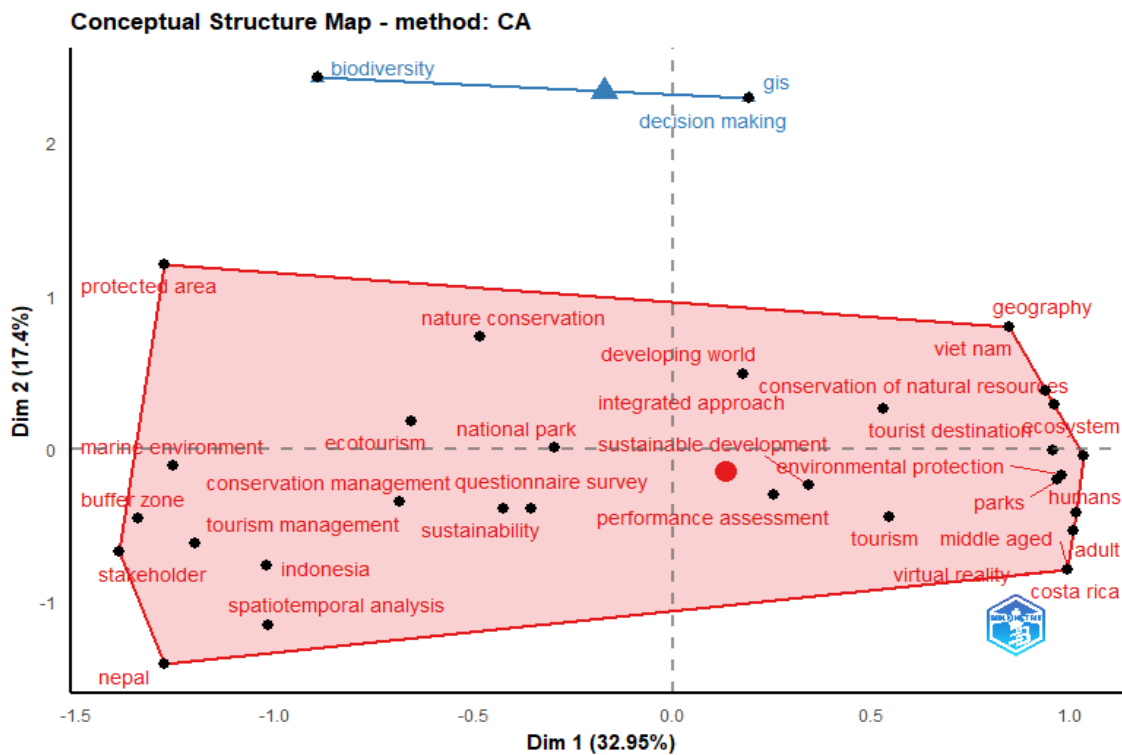
The most cited dataset papers regarding virtual reality technology and its relationship to national parks are shown in table 4.

Table 4. Most cited documents in dataset

Author	Source	DOI	Total Citations
Dangi & Gribb, 2018	Journal of Ecotourism	10.1080/14724049.2018.1502250	23
Yee et al. 2021	Journal of Environment Management	10.1016/j.jenvman.2021.112656	16
Fallah & Ocampo, 2021	Enviro Systems and Decisions	10.1007/s10669-020-09790-z	13
Pablo-Cea et al. 2021	Journal of Ecotourism	10.1080/14724049.2020.1772798	11
Sánchez et al., 2021	Science of Total Environment	10.1016/j.scitotenv.2021.148990	9
Marlina & Astina, 2020	GeoJournal of Tourism and Geosites	10.30892/GTG.32419-575	9
Lasso & Dahles, 202),	Tourism Geographies	10.1080/14616688.2021.1953123	7
Morais et al., 2018	Cogent Social Sciences	10.1080/23311886.2018.1490235	7

Source: own elaboration.

Figure 4. Factor analysis of dataset



Source: own elaboration

The set of data analyzed shows that research in the literature focuses on topics related to sustainable development, environmental protection, nature conservation, national parks, but very little on virtual reality, on the external line we see some studies, in Costa Rica, others related to middle aged, On the outer line we see some studies, in Costa Rica, others related to middle aged, adult, in areas farther away from the reference point in the figure 4, we see topics related to protected areas, marine

environment, as well as other contexts of application of technology, there is no evidence in the scientific literature of a strong link with national parks and tourism activity, being few documents that address the issue. See figure 4 showing the factor analysis of the dataset for the selected years 2018 to 2022.

## 4.2 Results of Survey

### 4.2.1 Survey result description and analysis of demographic characteristics

The sample is made up of 53.85% men and 46.15% women, their age range is between 30 and 49 years, which represents 63.07%, most of them travel with family and children, and their main purpose of their stay is leisure or tourism (see Table 5).

Table 5. Demographic characteristics

Variable	Responses	Total
Gender	Female	210
	Male	245
	Other	0
Age	18-29	103
	30-39	167
	40-49	120
	50-59	48
	60-69	15
	+70	2
Level of education	High School	81
	Studying at university	163
	University graduates	211
	Others	0

Source: own elaboration

#### 4.2.1. Sustainability and social norms

The results obtained show that the respondents give a high importance to the usefulness of VR apps that help to avoid damage to the environment (4.32), as it is the highest average. Finally, there is the consideration of the respondent about himself, when using VR apps (3.89).

In relation to the distribution of responses, a low standard deviation indicates that most of the data in a sample tend to be clustered near their mean. The lowest standard deviation corresponds to that same self-consideration, showing that there is consensus on these responses near the mean. Where there is the greatest degree of distribution is in When I use VR glasses, I think about how my actions can help the possible environmental impact of my sight? (0.960).

We say that there is negative (or left) asymmetry if the “tail” to the left of the mean is longer than that to the right, that is, if there are more separated values from the mean on the left. This result is what we observe in all items.

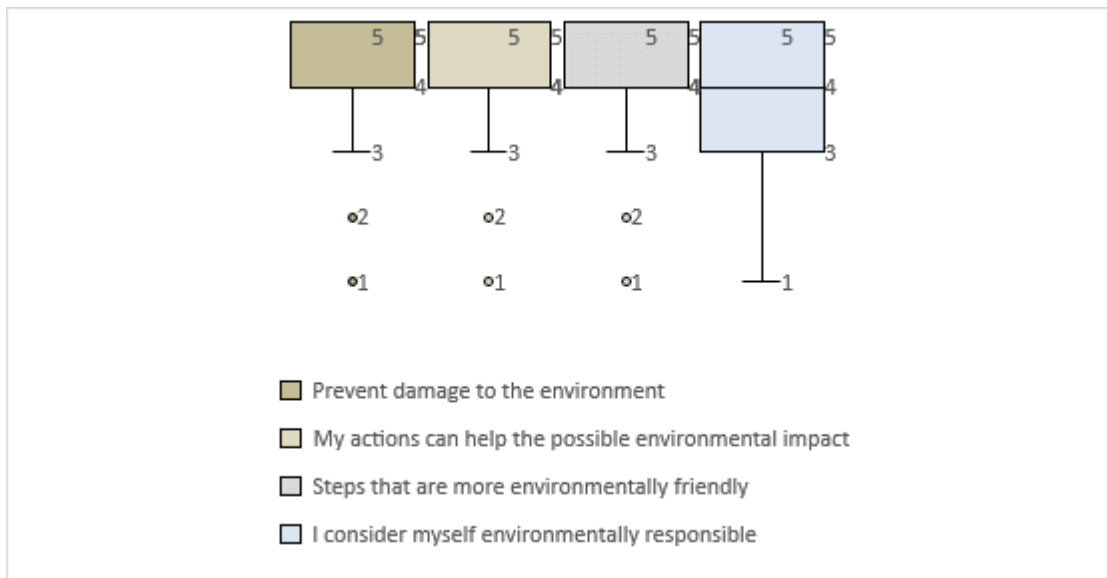
In relation to kurtosis, it is a statistical measure, which determines the degree of concentration that the values of a variable present around the central zone of the frequency distribution, resulting that Is it important that the VR applications I use help prevent damage to the environment? reaches the highest value (2.295) and that therefore, it is not only the question that raises more agreement, but it does it in a more concentrated way around the average obtained, as shown in Table 6.

Table 6. Descriptive analysis of items Sustainability

Items	Average	Standard deviation	Symmetry	Kurtosis
Is it important that the VR applications I use help prevent damage to the environment?	4.32	0.896	-1.496	2.295
When I wear my VR glasses I think about how my actions can help the possible environmental impact of my sight?	4.06	0.960	-1.009	0.687
Am I willing to use the VR glasses to take steps that are more environmentally friendly?	4.10	0.949	-1.194	1.399
When I use VR applications in national parks or environmental spaces, do I consider myself environmentally responsible?	3.89	1.095	-0.915	0.236

Source: own elaboration.

Figure 5. Results on the use of VR devices and the conservation of the environment



Source: own elaboration.

Figure 5 shows a negative asymmetrical distribution. The medians are closer to the third quartile, with a value equal to mode, the data is concentrated very close to the average, there is not much difference in the distribution in questions 1 to 3, 50% of the respondents totally agree on the importance of using VR applications to help prevent damage to the environment, 50% of the respondents agree and totally agree, that when using VR glasses they think about how their actions can help the environmental impact caused by their visit, so they are willing to use them as a more environmentally friendly measure. As for the fourth question, the distribution of the data has been widened, now 25% of the respondents ranging from Q1=3 to Q2=4 do not agree or disagree and 50%

agree and totally agree that by using VR applications in national parks they consider themselves environmentally responsible.

The horizontal lines in the box indicates the median values, respectively first box, Median = 5, mean 4.316, mode 5, outliers 8 for 1 and 13 values for 2. Second, Median =4, mean 4.062, mode 4, outliers 8 for 1 and 27 values for 2. Third, Median =4, mean 4.099, mode 4, outliers 11 for 1 and 20 values for 2, and fourth, Median =4, mean 3.886, mode 4, no atypical data values.

The answers obtained give greater importance to thinking that their friends and/or family of whom they value their opinion, will think well of them when using VR applications in national parks (3.67), but the lowest score considers, on average, that they neither agree nor disagree that to use VR applications in national parks they need to consult other people (3.03). In relation to distribution, the lowest standard deviation corresponds to whether they would think well of themselves when using VR applications by their family and/or friends of whom they value their opinion (1,156).

There is a negative asymmetry in all the elements we observed; in relation to kurtosis, the concentration of the values of one variable coincides with the variable with the highest average, giving importance to whether friends and/or family would think well of them if they used VR applications in the national parks (-0.167), as shown in Table 7.

Table 7. Descriptive analysis of items Social Norms

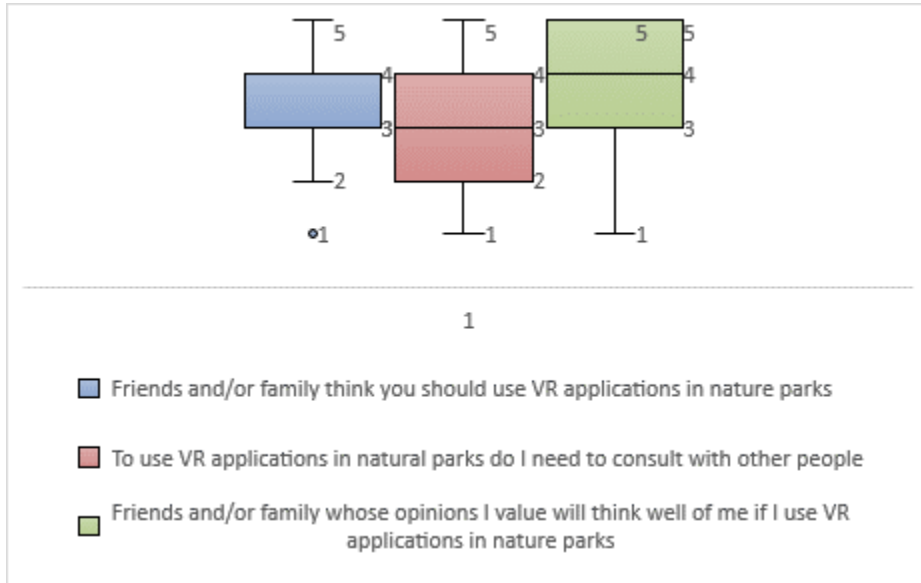
Items	Average	Standard deviation	Symmetry	Kurtosis
Do your friends and/or family think you should use VR applications in nature parks?	3.35	1.184	-0.382	-0.554
To use VR applications in natural parks do I need to consult with other people?	3.03	1.370	-0.155	-1.240
I think my friends and/or family whose opinions I value will think well of me if I use VR applications in nature parks?	3.67	1.156	-0.693	-0.167
Do your friends and/or family think you should use VR applications in nature parks?	3.35	1.184	-0.382	-0.554

Source: own elaboration.

Figure 6 shows that for the first question, approximately 50% of the respondents agree that their friends and/or family members think that they should use VR applications in the national parks, but for the second question, to know if they should consult another person to use VR applications, the distribution is wide, with 25% considering that they disagree and another 25% sharing between those who consider that they neither agree nor disagree and others who agree, possibly due to the importance or influence of these opinions in family and social life. As for the third question, 50% of respondents consider that they agree and totally agree that their friends and/or family will think well of them to use VR applications in national parks, this denotes the importance of social and environmental values for most respondents.

The horizontal lines in the box indicates the median values, respectively first box, Median = 3, mean 3.345, mode 3, outliers 45 for 1. Second, Median =3, mean 3.029, mode 4, no atypical data values, and third, Median =4, mean 3.668, mode 4, no atypical data values.

Figure 6. Behavioral aspects of VR use : friends/family



Source: own elaboration.

#### 4.2.2. Intent to Use VR

Respondents place greater importance on recommending the VR glasses to others who want to get an idea of the national park (3.89), as well as on planning to use the VR glasses to virtually observe the national park (3.86), but the lowest score considers on average neither agreeing nor disagreeing with continuing to use VR in national parks on a regular basis (3.41). In relation to the distribution, the lowest standard deviation corresponds to plan to use the VR glasses to virtually observe the national park or environmental space that I would like to visit (1,061).

Table 8. Descriptive analysis of items Intent to Use VR

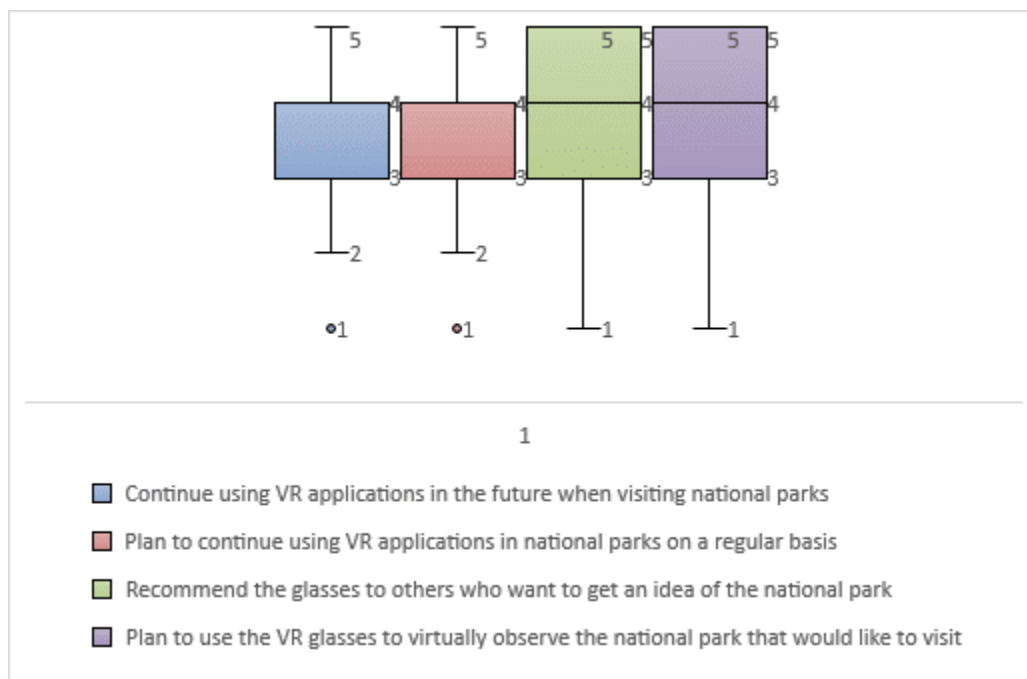
Items	Average	Standard deviation	Symmetry	Kurtosis
Do you intend to continue using VR applications in the future when visiting national parks or environmental sites?	3.49	1.180	-0.468	-0.546
Do you plan to continue using VR applications in national parks or environmental areas on a regular basis?.	3.41	1.175	-0.421	-0.563
Would you recommend the VR glasses to others who want to get an idea of the national park or natural environment?	3.89	1.055	-1.090	0.929
Do you plan to use the VR glasses to virtually observe the national park or environmental space that I would like to visit?	3.86	1.061	-1.040	0.721

Source: own elaboration.

There is a negative asymmetry in all the items we observe; in relation to kurtosis, the concentration of the values of one variable results in recommend the VR glasses to others who want to get an idea of the national park with the highest value (0.929), followed by plan to use the VR glasses to virtually observe the national park that I would like to visit? (0.721). Therefore, these are the questions you most agree with, as shown in Table 8.

The data shows a negative asymmetrical distribution. The medians are closer to the third quartile, with a value equal to mode, and it is interesting that for both question one and question two, 25% of the people consider that they do not agree with the intention of continuing to use VR applications in the future when visiting national parks, nor do they plan to do so on a regular basis, but 50% of the respondents would recommend to others to use VR glasses to get an idea of the national park they would like to visit, similarly in the fourth question 50% plan to use VR glasses to virtually observe the national parks they would like to visit, reflecting a potential for tourism promotion for these environments, as seen in figure 7.

Figure 7. Results on re-use/recommend VR applications



Source: own elaboration.

The horizontal lines in the box indicates the median values, respectively first box, Median = 4, mean 3.488, mode 4, outliers 35 for 1. Second, Median =4, mean 3.413, mode 4, outliers 38 for 1. Third, Median =4, mean 3.895, mode 4, no atypical data values, and fourth, Median =4, mean 3.859, mode 4, no atypical data values.

## 5. Discussion

### 5.1 RQ 1. How virtual reality can be an instrument at the service of sustainability?

VR can be used to make visits to natural areas more sustainable. In the context of the study, we have seen the presence of many species of flora and fauna and some in danger of extinction. Here, ecotourism together with VR allows for a playful learning experience, virtual diving or visits to

archaeological sites, providing historical-cultural content with a high emotional impact (Bruno et al., 2018). The use of camera traps, geolocation systems used in these parks, allow the study and recording of species, but in other contexts we see options such as thermal imaging obtained using systems of remotely piloted aircraft and the use of VR by experts in these natural areas can facilitate the monitoring of species and improve predictions of their distribution and conservation mainly vulnerable and protected (Leigh et al., 2019).

Given that a large part of the territory is dedicated to conservation, it becomes an economic challenge to maintain and strengthen these natural areas, even more so when it is necessary to improve the infrastructure, access and greater implementation of technology in many national parks. Therefore, the support of philanthropic organizations in raising funds is necessary and desirable, the use of VR "Non-profit organizations are increasingly marketing their causes using virtual reality and they report increased donations when VR technology is employed" (Nelson et al., 2020, p.1). Investment in national parks can include VR evacuation plans for forest fires that sometimes occur in dry seasons mainly due to climate change, as a prevention measure for visitors and to mitigate imminent environmental damage. Some studies have been conducted using VR for fires in high rise buildings but the concept is applicable to natural areas (J. F. Zhang & Wang, 2012). Although our results show an incipient use of ICTs and especially RV in Costa Rica's national parks, being its use basically promotional and in the educational field to raise awareness in schools and communities, its importance to incorporate them and use them as an information tool is a new way of understanding tourism, as a consequence of the evolution of society, being necessary to integrate environmental, socio-cultural and economic factors (Solís-Radilla et al., 2019).

Tourists who visit natural areas have their own expectations and expect to enjoy a memorable experience, therefore the relationship of sustainability and expectations can be enhanced through virtual reality to offer a previous experience to determine if it meets their expectations (Palos-Sanchez et al., 2021). In other words, going beyond the information offered by tourist platforms, promotional brochures, blogs, social networks and videos of people who tell their experiences, respecting the very personal decision to choose the medium they want, we believe there is an opportunity to explore the use of technologies through a process of open innovation, taking advantage of the large amount of information available in those media and modernize and update the records of visitors (Del Vecchio et al., 2018).

We found many people who benefit directly from the activity of conservation and protection of natural resources, some as collaborators, others are organized groups, with an indirect economic impact on nearby communities, this in line with a study that found that the perceived benefits of the national park for sustainability were first environmental and then economic and social (Parker et al., 2017). The use of ICTs, such as augmented reality during tours or virtual reality as a personalized information and promotion tool, is not evident in most parks. There are options such as 360 degree video tours but there has not been a boom in these applications, government support is more evident with the payment of environmental services that promotes the conservation of private areas; in contexts such as Canada residents participate in municipal planning processes trying to modernize planning tools to achieve a greater impact on sustainability (Vaugeois et al., 2017).

One result obtained refers to accessibility, but this can be approached from various angles, such as a physical or mental disability, problems that may be related to age, or diseases or disorders that the visitor to the national park may present (Arenas-Escaso et al., 2022). One study uses virtual reality to expose participants to a green environment to mitigate anxiety, i.e., natural areas even when simulated provide a benefit to decrease anxiety (O'Meara et al., 2020). Research has been conducted using VR as an alternative therapy inspired by nature for stress relief (Valtchanov, 2010); as well as pain in cancer patients, where simulation achieved significant increases in relaxation, sense of peace, and positive distractions (Scates et al., 2020). The competitiveness in the companies and the labor challenges increase the levels of stress reason why the visit presence, mixed virtual reality or virtual are excellent

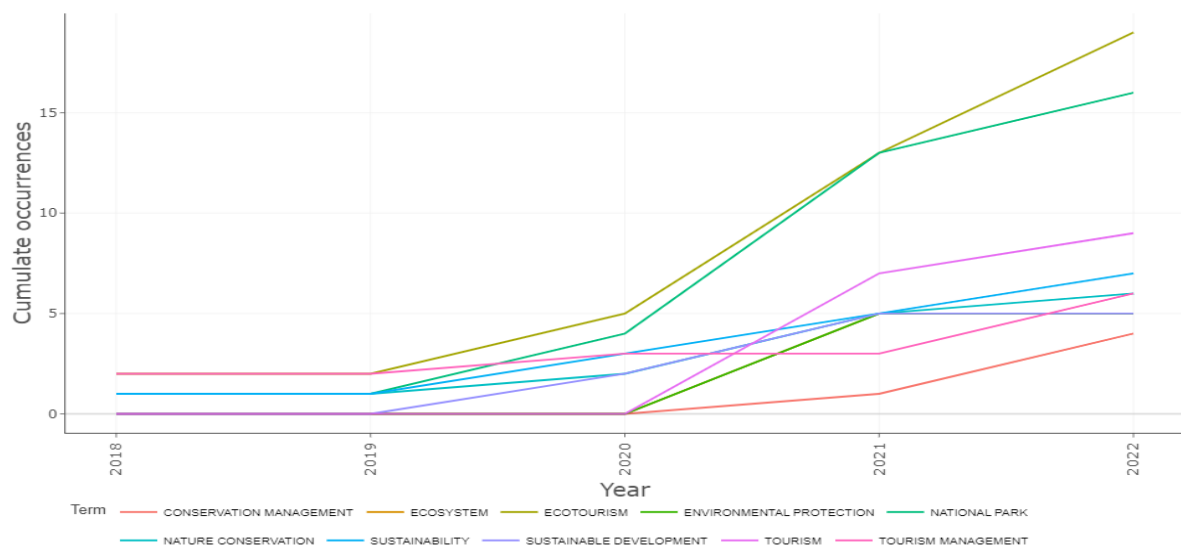


options like therapy and natural balance; it is recommended to people with limited access to natural zones to consider the use of VR to promote the mental health (Browning et al., 2019). The absence of VR information rooms in natural areas denies access to people who cannot make the full journey, even though there are parks with walkways with handrails and signs that are designed for blind people, the reality is that as well as the use of VR, it is an excellent alternative, The problem in many cases is that accessibility standards are formulated without consulting the people affected (Chikuta et al., 2019).

## 5.2. RQ 2.-Which advantages of virtual reality are most relevant in the scientific literature?

The literature consulted through SLR from 2018 to 2022, evidences few studies related to virtual reality and its application for the benefit of national parks, however, the advantages of this technology encompasses many fields of knowledge. Figure 8 shows how interest in studying topics related to environmental protection and ecotourism is increasing.

Figure 8. Evolution of researched topics



Source: own elaboration.

The advantages of using Virtual Reality applications in National Parks can be summarized as accident prevention, visitor education and awareness, greater accessibility to the Park for the most vulnerable groups, mitigation of climatic consequences during the visit and contribution to animal satisfaction, protection and, in general, increased sustainability.

These arguments are already supported by scientific literature. Thus, there are studies that affirm that, as tourism develops, new forms of tourism also emerge. Especially ecotourism, which loses authenticity to give way to a growing volume of visitors in favor of the development of the areas visited. However, this has allowed the emergence of new sustainable forms of tourism (Dewailly, 1999).

Sometimes national parks count with great wealth of both biodiversity and geothermal sites or majestic volcanoes, so virtual reality would be of great help before entering these places, given the lack of academic literature on risk management in volcanoes and geothermal tourism (Erfurt-Cooper, 2011).

Another advantage of using VR is equality for people with disabilities, this is a key component of sustainability, even when there may be vulnerability to environmental hazards (Salkeld, 2016). Virtual reality can be used successfully in anxiety disorders, including phobias, studies show the therapeutic potential for anxiety management. nature-based mindfulness VR experience.(Tarrant et al., 2018).

The unquestionable advantage of virtual reality applied to disabilities or to the occurrence of situations as extraordinary as the Covid-19 pandemic, is found in the emotional aspect, generating new sensations or emotions and stimulating the senses and abilities. According to Boffi et al. 2022 a natural environment such as a garden has a restorative effect on mental fatigue, prevents stress, provides benefits to revitalize physical and psychological resources.

### 5.3. RQ 3. What are some of the benefits for parks?

Nowadays we face stressful situations that can be mitigated through ecotourism as well as virtual reality applications, such as games, videos. Wang et al., 2019 conduct a study focusing on forest resting environments. , showing a virtual reality video, using stress level as the dependent variable, even though there are effects on stress relief, the aquatic landscape had a positive effect on stress relief, so the forest environment allows according to the author, a better use for forest therapy services.

There are applications that provide interactive information about the species of flora and fauna present in the visited park. This helps the conservation and protection of endangered species, the conservation of forests, as well as the archaeological heritage sites present in these natural parks.

In the development of the research, examples of educational programs that may be ineffective are evident, such as signs and warnings. These are used in many parks but go unnoticed. That is why virtual reality is an excellent educational tool for the information and prevention of risks in the park. It even allows to show different species and trails and it informs on relevant aspects about such species. It allows to know the access to the park, the distances, the seasons, the conditions of the ground, if you must walk upwards or for long distances (Zarzuela et al., 2013).-According to Ballantyne et al. (2009) it is common to justify a tourist attraction by wildlife, ensuring the conservation of wildlife and its associated habitat. However, the secret seems to lie in the visitor's awareness of conservation issues and the impact of their visit, as well as their acceptance of all the conservation messages they are shown before and during the visit.

It is important to explore the educational aspect as a feature to make use of on applications, such as games, informative videos or 360 degree tours, which can be very similar to the real world (Wagler & Hanus, 2018); training on safety aspects and recommendations to follow in the place visited, in order to ensure the well-being of tourists, and the species of flora and fauna present during the visit, such is the case of the game that allows people to get to know the city of Valladolid in Spain, recreating historical buildings (Zarzuela et al., 2013).. It can also be applied in more practical training environments, through the use of 3D virtual reality applications that can be used in the classroom or in places with the presence of nature in order to train tour guides (Tseng et al., 2013). Leisure tourism takes importance in natural areas for the routes and harmony with nature, these environments are exploited in VR applications for learning as the case of physical education, where in addition to avoiding the risk of injury, being a solution to the challenges in access, task progression and / or security (Pasco, 2013).

A benefit-of using VR applications in national parks is related to accessibility, the mixed visit is a very personal decision, many times people who live near the parks can have a higher probability of visiting them (Weber & Sultana, 2013). Studies show that travel distance has a significant impact on visits to national parks (Zhang et al., 1999)). In this sense, it seems that VR production could mitigate adverse conditions that affect the tourist experience, such as weather conditions, such as heat or sudden heavy rain in the middle of a visit to the Park. It can reduce visitor limitations, "With demographic change, the number of older hikers who visit National Parks and other natural recreational areas will increase" (Schamel & Job, 2017).

According to Guttentag (2010) as virtual reality technology continues to evolve, applications will increase not only in quantity but also in importance for researchers and professionals in the touristic sector.

Virtual reality allows the reconstruction of historical sites through the scanning and visualization of archaeological findings, maps of the distribution and location of sites and objects, which are obtained for their location and protection. Technological advances allow three-dimensional educational tours that show the routes, the species, and attractions of the national park through geo-educational options with the use of applications and games, which is a useful learning tool in fields related to forests and cultural heritage (Folgado-Fernández et al., 2017). Education allows people to become aware of geological heritage, and the importance of conservation and protection as human beings, by developing attitudes and skills regarding natural fragility and the capacity to solve environmental problems and impacts (Martínez-Graña et al., 2014).

Guayabo National Monument in Costa Rica has been an example of restoration with the help of technology, since the weather conditions and the passage of time has deteriorated, the restorations allow the resurgence of this historic architectural heritage, is recognized as “World Engineering Heritage” by the American Association of Civil Engineers (ASCE) since 2009 (MCJ, 2019).

#### 5.4. RQ 4. What do park visitors think of VR and its possibilities?

The Costa Rican context and the tourist survey were used to answer this research question. The results show great potential for the promotion of national parks through VR technology, indicating their willingness to use it to learn about the options they want to visit, even considering that their friends and family whose opinions are important to them would think well of using these applications in national parks, have expressed their concern about environmental damage and that the actions they take impact positively on the environment (Carvache-Franco et al., 2022). Not everyone feels environmentally responsible in using the applications, but they clearly do not need to consult others to use them, and even though some people may disagree with using VR applications in the future or frequently, they would use them to get to know the park and recommend the use of the glasses to others so that they have an idea of the national park and what to expect (Palos-Sanchez et al., 2021).

In the literature we found research that explores factors for VR use and influence on tourist behavioral intent in the Lake District National Park, this park developed a VR application with a flight over the landscape, finding that the factors that influence the adoption of VR in the national park are usability, hedonic benefits (enjoyment and experienced realism), emotional benefits (people’s memories and the creation of meaningful bonds with places), social benefits, attitude, and behavioral intent, tourists indicated that the use of the application influences the intention to return to the site and to recommend it to others (Dieck et al., 2018). Very similar to those expressed by respondents in our study, in terms of their intention to use it and to recommend it as a promotional tool.

We believe that there must be agents of change, which allow for a change in the way ecotourism is viewed and allow for the use of RV resources, through personal and organizational change that allows for these processes of transition to sustainability (Westley et al., 2013); considering the context with potential for growth in RV benefits such as Costa Rica's national parks.

## 6. Conclusion

When analyzing the social dimension of the model, we found that most of the people surveyed have environmental values that motivate them to use VR applications to prevent environmental damage, trying to mitigate the damage to the national park through their actions during the visit, i.e., their position is positive for the use in favor of the sustainability of the environment.

With respect to the sustainability dimension, virtual reality has important advantages that can be at the service of sustainability, such as the opportunity to obtain funding from philanthropic organizations, NGOs or other interested parties. We emphasize the advantages of this technology as a complement to the visit, while the decision to replace it is up to the person visiting the site.

With respect to the intentional dimension of VR use, they may be enhanced by the conditions of access to some national parks, such as the sea, rivers or rugged areas, as well as the visitor's own conditions, such as health and age; this may tip the balance in favor of VR use.

As for the relationship between economic and environmental benefits and implementing this technology, the evidence shows that VR is recommended to mitigate risks associated with the visit, the stress generated to local species, the damage caused to park infrastructure and the conservation of endangered species, while the implementation of mixed visits and education prior to entry, are advantages that can be exploited by national parks, in addition, it can help in as therapy for the treatment of phobias, anxiety or stress.

People show interest in using technology for the benefit of the environment, this represents an opportunity to develop applications similar to those of more developed contexts, which provide multiple options, from geolocation, availability of services, attractions, historical and promotional information, description of species, warnings, activation of the park, etc., to the use of the technology for the benefit of the environment.

A limitation of this study could derive from the fact that tourism activities are analysed in specific geographical and temporal contexts. Therefore, the results obtained must be interpreted within this context and not generalised. Another limitation may be the currently limited literature on VR and national parks.

Future research can explore the acceptance of VR applications tested directly in tourist destinations and national parks through awareness campaigns in schools in the context of nature conservation education.

This study also provides evidence that managers need to implement new destination positioning strategies based on tourists' VR experiences. Another practical contribution of this study is the importance of sustainability and the digital economy for the economic development of the territory, thus reinforcing the local and unique characteristics of the destination.

Therefore, this work is of particular importance for the diagnosis, implementation and follow-up of training plans on conservation issues, for organisations dedicated to environmental protection, tourism entrepreneurs and their environmental responsibility, national park governance and educational outreach activities as a means of change for the conservation of natural resources.

## References

1. Ács, Z. J., Lafuente, E., & Szerb, L. (2022). A note on the configuration of the digital ecosystem in Latin America. *Tec Empresarial*, 16(1), 1-19. <https://doi.org/10.18845/te.v16i1.5926>
2. Ahn, M., Kang, J., & Hustvedt, G. (2016). A model of sustainable household technology acceptance. *Int. J. Consum. Stud*, 40, 83-91. <https://doi.org/10.1111/ijcs.12217>
3. Álvarez-García, J., Durán-Sánchez, A., Río-Rama, D., & Cruz, M. (2018). Scientific coverage in community-based tourism: Sustainable tourism and strategy for social development. *Sustainability*, 10, 1158. <https://doi.org/10.3390/su10041158>
4. Arenas-Escaso, J. F., Folgado-Fernández, J. A., & Palos-Sánchez, P. R. (2022). Digital Free Tourism (DFT) o desconectar para volver a conectar: Una oportunidad económica y turística. *Suma de Negocios*, 13(28), 39-49. <https://doi.org/10.14349/sumneg/2022.v13.n28.a5>
5. Bartol, T., Budimir, G., Dekleva-Smrekar, D., Pusnik, M., & Juznic, P. (2014). Assessment of research fields in Scopus and Web of Science in the view of national research evaluation in Slovenia. *Scientometrics*, 98, 1491-1504. <https://doi.org/10.1007/s11192-013-1148-8>

6. Boffi, M., Pola, L. G., Fermani, E., Senes, G., Inghilleri, P., Piga, B. E. A., & Fumagalli, N. (2022). Visual post-occupancy evaluation of a restorative garden using virtual reality photography: Restoration, emotions, and behavior in older and younger people. *Frontiers in Psychology*, 13, 1-20. <https://doi.org/10.3389/fpsyg.2022.927688>
7. Browning, M. H., Mimnaugh, K. J., Riper, C. J., Laurent, H. K., & LaValle, S. M. (2019). Can simulated nature support mental health? Comparing short, single-doses of 360-degree nature videos in virtual reality with the outdoors. *Front. Psychol*, 10. <https://doi.org/10.3389/fpsyg.2019.02667>
8. Brundtland, G. & O.N.U. (1988). Our Common future (*Brundtland Report*). [https://doi.org/10.9774/gleaf.978-1-907643-44-6\\_12](https://doi.org/10.9774/gleaf.978-1-907643-44-6_12)
9. Bruno, F., Barbieri, L., Lagudi, A., Cozza, M., Cozza, A., Peluso, R., & Muzzupappa, M. (2018). Virtual dives into the underwater archaeological treasures of South Italy. *Virtual Real*, 22, 91-102. <https://doi.org/10.1007/s10055-017-0318-z>
10. Carvache-Franco, O., Viquez-Paniagua, A. G., Carvache-Franco, M., Pérez-Orozco, A., & Carvache-Franco, W. (2022). Risk perception and crisis communication during the Covid-19 pandemic: Analysis based on Twitter hashtags. *Tec Empresarial*, 16(3), 72-91. <https://doi.org/10.18845/te.v16i3.6372>
11. Chikuta, O., Plessis, E., & Saayman, M. (2019). Accessibility expectations of tourists with disabilities in national parks. *Tour. Plan. Dev*, 16, 75-92. <https://doi.org/10.1080/21568316.2018.1447509>
12. Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the fuzzy sets theory field. *J. Informetr*, 5, 146-166. <https://doi.org/10.1016/j.joi.2010.10.002>
13. Dangi, T. B., & Gribb, W. J. (2018). Sustainable ecotourism management and visitor experiences: Managing conflicting perspectives in Rocky Mountain National Park, USA. *Journal of Ecotourism*, 17(3), 338-358. <https://doi.org/10.1080/14724049.2018.1502250>
14. Del Vecchio, P., Mele, G., Ndou, V., & Secundo, G. (2018). Open innovation and social big data for sustainability: Evidence from the tourism industry. *Sustainability*, 10, 3215. <https://doi.org/10.3390/su10093215>
15. Dieck, D., Dieck, M. C., Jung, T., & Moorhouse, N. (2018). Tourists' virtual reality adoption: An exploratory study from Lake District National Park. *Leis. Stud*, 37, 371-383. <https://doi.org/10.1080/02614367.2018.1466905>
16. Dvorský, J., Petráková, Z., Ajaz Khan, K., Formánek, I., & Mikoláš, Z. (2020). Selected Aspects of Strategic Management in the Service Sector. *Journal of Tourism and Services*, 20(11), 109-123. <https://doi.org/10.29036/jots.v11i20.146>
17. D.W. (2019). *Costa Rica, a small country with great biodiversity*. <https://www.thecostaricaonline.com/blog/biodiversity-in-costa-rica>
18. Elseiver. (2020). <https://www.elsevier.com/es-mx/solutions/scopus>
19. Erfurt-Cooper, P. (2011). *Geotourism in Volcanic and Geothermal Environments: Playing with Fire?* <https://dx.doi.org/10.1007/>
20. Fallah, M., & Ocampo, L. (2021). The use of the Delphi method with non-parametric analysis for identifying sustainability criteria and indicators in evaluating ecotourism management: The

- case of Penang National Park (Malaysia). *Environment Systems and Decisions*, 41(1), 45-62. <https://doi.org/10.1007/s10669-020-09790-z>
21. Folgado-Fernández, J. A., Palos-Sánchez, P. R., Campón-Cerro, A. M., & Hernández-Mogollón, J. M. (2017). Productos gastronómicos con identidad y desarrollo del destino turístico. Un estudio sobre rutas del queso en España. *International Journal of Scientific Management and Tourism*, 3(1), 93-109.
  22. Fonafifo, M.-S.-C.-. (2019). Summary of the Sixth Report National of Costa Rica before the Convention on Biological Diversity. En Nations Program United Nations Development Programme—Technical Support for Eligible Parties to Develop the Sixth National Report for the CBD (6NR-LAC. Costa Rica. <https://www.informea.org/en/national-report/costa-rica-sixth-national-report>
  23. Guan, C., Rani, T., Yueqiang, Z., Ajaz, T., & Haseki, M. I. (2022). *Impact of tourism industry, globalization, and technology innovation on ecological footprints in G-10 countries*. <https://doi.org/10.1080/1331677X.2022.2052337>
  24. Guttentag, D. A. (2010). Virtual reality: Applications and implications for tourism. *Tourism Manage*, 31, 637-651. <https://doi.org/10.1016/j.tourman.2009.07.003>
  25. Harvey, L. (2007). Allowable CO<sub>2</sub> concentrations under the United Nations Framework Convention on Climate Change as a function of the climate sensitivity probability distribution function. *Environ. Res. Lett*, 2, 014001. <https://doi.org/10.1088/1748-9326/2/1/014001>
  26. Huang, Z., Weng, L., & Bao, J. (2022). How do visitors respond to sustainable tourism interpretations? A further investigation into content and media format. *Tourism Management*, 92, 104535. <https://doi.org/10.1016/j.tourman.2022.104535>
  27. Hurst, S. D. (1998). Use of “virtual” field trips in teaching introductory geology. *Comput. Geosci*, 24, 653-658. [https://doi.org/10.1016/s0098-3004\(98\)00043-0](https://doi.org/10.1016/s0098-3004(98)00043-0)
  28. ICT. (2022). <https://www.ict.go.cr/es/documentos-institucionales/estad%C3%ADsticas/informes-estad%C3%ADsticos/recientes/2082-2022/file.html>
  29. IGN. (2018). National Parks in 3D. Ministry of Promotion Magazin. [https://www.mitma.gob.es/recursos\\_mfom/comodin/recursos/ju36\\_39.pdf](https://www.mitma.gob.es/recursos_mfom/comodin/recursos/ju36_39.pdf).
  30. Israel, K., Tscheulin, D. K., & Zerres, C. (2019). Virtual reality in the hotel industry: Assessing the acceptance of immersive hotel presentation. *Eur. J. Tour. Res*, 21, 5-22. <https://doi.org/10.54055/ejtr.v21i.355>
  31. Jacobson, S. K., & Lopez, A. F. (1994). Biological impacts of ecotourism: Tourists and nesting turtles in Tortuguero National Park, Costa Rica. *Wildl. Soc. Bull*, 22, 414-419. <http://www.jstor.org/stable/3783383>
  32. Jiang, S., Scott, N., & Tao, L. (2019). Antecedents of augmented reality experiences: Potential tourists to Shangri-La Potatso National Park, China. *Asia Pacific Journal of Tourism Research*, 24(10), 1034-1045. <https://doi.org/10.1080/10941665.2019.1653949>
  33. Kamri, T., & Radam, A. (2013). Visitors’ visiting motivation: Bako national park, Sarawak. *Procedia-Social and Behavioral Sciences*, 101, 495-505. <https://doi.org/10.1016/j.sbspro.2013.07.223>
  34. Lasso, A. H., & Dahles, H. (2021). A community perspective on local ecotourism development: Lessons from Komodo National Park. *Tourism Geographies*, 1-21. <https://doi.org/10.1080/14616688.2021.1953123>

35. Leigh, C., Heron, G., Wilson, E., Gregory, T., Clifford, S., Holloway, J., & Mengersen, K. (2019). Using virtual reality and thermal imagery to improve statistical modelling of vulnerable and protected species. *PloS One*, 14, 0217809. <https://doi.org/10.1371/journal.pone.0217809>
36. Levi, D., & Kocher, S. (1999). Virtual nature: The future effects of information technology on our relationship to nature. *Environment and Behavior*, 31, 203-226. <https://doi.org/10.1177/00139169921972065>
37. Lin, S., Hu, X., Chen, H., Wu, C., & Hong, W. (2022). Spatio-temporal variation of ecosystem service values adjusted by vegetation cover: A case study of Wuyishan National Park Pilot, China. *Journal of Forestry Research*, 33(3), 851-863. <https://doi.org/10.1007/s11676-021-01364-2>
38. Lopez-Garro, A., Zanella, I., Golfín-Duarte, G., & Perez-Montero, M. (2020). Residency of the whitetip reef shark (*Triaenodon obelus*) in Chatham and Wafer Bays, Isla del Coco National Park, Costa Rica. *Rev. Biol. Trop.*, 68, 330-339. <https://doi.org/10.15517/rbt.v68is1.41203>
39. Marlina, S., & Astina, I. K. (2020). Sustainable marine ecotourism management: A case of marine resource conservation based on local wisdom of bajo mola community in wakatobi national park. *GeoJournal of Tourism and Geosites*, 32(4), 1317-1323. <https://doi.org/10.30892/gtg.32419-575>
40. Martínez-Graña, A., González-Delgado, J., & Pallarés, S. (2014). *3D Virtual Itinerary for Education Using Google Earth as a Tool for the Recovery of the Geological Heritage of Natural Areas: Application in the Las Batuecas Valley* (Vol. 6). Nature Park (Salamanca).
41. Martín-Martín, A., Orduna-Malea, E., Thelwall, M., & López-Cózar, E. D. (2018). Google Scholar, Web of Science, and Scopus: A systematic comparison of citations in 252 subject categories. *J. Informetr.*, 12, 1160-1177. <https://doi.org/10.1016/j.joi.2018.09.002>
42. MCJ. (2019). Ministry of Culture and Youth. <https://mcj.go.cr/>
43. MINAE. (2018). Decarbonization Plan. <https://minae.go.cr/images/pdf/Plan-de-Descarbonizacion-1.pdf>
44. Morais, J., Castanho, R. A., Pinto-Gomes, C., & Santos, P. (2018). Characteristics of Iona National Park's visitors: Planning for ecotourism and sustainable development in Angola. *Cogent Social Sciences*, 4(1), 1490235. <https://doi.org/10.1080/23311886.2018.1490235>
45. Nelson, K. M., Anggraini, E., & Schlüter, A. (2020). Virtual reality as a tool for environmental conservation and fundraising. *Plos One*, 15, 0223631. <https://doi.org/10.1371/journal.pone.0223631>
46. O'Meara, A., Cassarino, M., Bolger, A., & Setti, A. (2020). Virtual Reality Nature Exposure and Test Anxiety. *Multimodal Technol. Interaction*, 4, 75. <https://doi.org/10.3390/mti4040075>
47. Ortiz, P. (2017). *The Ascent to Mount Teide in Virtual Reality of Crea Solutions obtains more than 41 Million views in Google Street View*. <https://www.creasolutions.es/2017/07/el-ascenso-al-teide-en-realidad->
48. Pablo-Cea, J. D., Velado-Cano, M. A., & Noriega, J. A. (2021). A first step to evaluate the impact of ecotourism on biodiversity in El Salvador: A case study using dung beetles in a National Park. *Journal of Ecotourism*, 20(1), 51-69. <https://doi.org/10.1080/14724049.2020.1772798>
49. Palos-Sánchez, P. R., Folgado-Fernández, J. A., Sánchez, M. A. R., Sánchez, P. R. P., Folgado-Fernández, J. A., & Sánchez, M. A. R. (2022). Virtual Reality Technology: Analysis based on

- text and opinion mining. *Mathematical Biosciences and Engineering*, 19(8), Art. mbe-19-08-367. <https://doi.org/10.3934/mbe.2022367>
50. Palos-Sanchez, P., Saura, J. R., & Correia, M. B. (2021). Do tourism applications' quality and user experience influence its acceptance by tourists? *Review of Managerial Science*, 15(5), 1205-1241.
  51. Parker, P., Rollins, R., Murray, G., Chafey, A., & Cannessa, R. (2017). Community perceptions of the contributions of parks to sustainability in Canada. *Leisure/Loisir*, 41, 365-389. <https://doi.org/10.1080/14927713.2017.1352455>
  52. Pasco, D. (2013). The Potential of Using Virtual Reality Technology in Physical Activity Settings. *Quest*, 65(4), 429-441. <https://doi.org/10.1080/00336297.2013.795906>.
  53. Rahman, F. A., Arifin, K., Abas, A., Mahfudz, M., Basir Cyio, M., Khairil, M., & Samad, M. A. (2022). Sustainable safety management: A safety competencies systematic literature review. *Sustainability*, 14(11), 6885. [10.3390/14116885](https://doi.org/10.3390/su14116885).
  54. Rhama, B., & Kusumasari, B. (2022). Assessing resource-based theory in ecotourism management: The case of Sebangau National Park, Indonesia. *International Social Science Journal*, 72(245), 613-634. <https://doi.org/10.1111/issj.12345>
  55. Rojas-Sánchez, M. A., Palos-Sánchez, P. R., & Folgado-Fernández, J. A. (2022). Systematic literature review and bibliometric analysis on virtual reality and education. *Education and Information Technologies*. <https://doi.org/10.1007/s10639-022-11167-5>
  56. Salkeld, D. F. (2016). Sustainable lifestyles for all? Disability equality, sustainability and the limitations of current UK policy. *Disability & Society*, 31(4), 447-464. <https://doi.org/10.1080/09687599.2016.1182011>.
  57. Sánchez, M. R., Palos-Sánchez, P. R., & Velicia-Martin, F. (2021). Eco-friendly performance as a determining factor of the Adoption of Virtual Reality Applications in National Parks. *Science of the Total Environment*, 798, 148990. <https://doi.org/10.1016/j.scitotenv.2021.148990>
  58. Scates, D., Dickinson, J. I., Sullivan, K., Cline, H., & Balaraman, R. (2020). Using nature-inspired virtual reality as a distraction to reduce stress and pain among cancer patients. *Environment and Behavior*, 52(8), 895-918. <https://doi.org/10.1177/0013916520916259>
  59. Schamel, J., & Job, H. (2017). National Parks and demographic change—Modelling the effects of ageing hikers on mountain landscape intra-area accessibility. *Landsch. Urban Plan*, 163, 32-43. <https://doi.org/10.1016/j.landurbplan.2017.03.001>
  60. SINAC. (2021). Annual Statistics Report SEMEC 2021: SINAC in Numbers” (C. B. Pavlotzky, Ed.). <https://www.sinac.go.cr/ES/transprncia/Informe%20SEMEC/Informe%20SEMEC%202021.pdf>
  61. SINAC. (2022). Áreas Silvestres Protegidas de Costa Rica Julio 2022. <https://www.sinac.go.cr/ES/asp/Paginas/default.aspx>
  62. Solís-Radilla, M. M., Hernández-Lobato, L., Callarisa-Fiol, L. J., & Pastor-Durán, H. T. (2019). The Importance of Sustainability in the Loyalty to a Tourist Destination through the Management of Expectations and Experiences. *Sustainability*, 11, 4132. <https://doi.org/10.3390/su11154132>



63. Tarrant, J., Viczko, J., & Cope, H. (2018). Virtual reality for anxiety reduction demonstrated by quantitative EEG: a pilot study. *Frontiers in Psychology*, 9. <https://doi.org/10.3389/fpsyg.2018.01280>
64. Trespalacios, J. A., Vázquez, R., & Bello, L. (2005). *Marketing Research, Methods of Collection and Analyze Information for Decision in Marketing*.
65. Tseng, S. P., Huang, M. W., & Liu, H. J. (2013). *A Virtual Reality Based Training System for Cultural Tourism*. Proceedings of the International Conference on Web-Based Learning, 272-277.
66. Valtchanov, D. (2010). *Physiological and affective responses to immersion in virtual reality: Effects of nature and urban settings* [(Master's thesis,]. University of Waterloo.
67. Vaugeois, N., Schroeder, J., & Harnett, M. (2017). The role of leisure in integrated community sustainability plans within Canada. *Leisure/Loisir*, 41, 343-364. <https://doi.org/10.1080/14927713.2017.1365621>
68. Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36, 157-178. <https://doi.org/10.2307/41410412>
69. Wagler, A., & Hanus, M. D. (2018). Comparing Virtual Reality Tourism to Real-Life Experience: Effects of Presence and Engagement on Attitude and Enjoyment. *Communication Research Reports*, 35(5), 456-464. <https://doi.org/10.1080/08824096.2018.1525350>; <https://doi.org/10.1080/08824096.2018.1525350>
70. Weber, J., & Sultana, S. (2013). Why do so few minority people visit National Parks? Visitation and the accessibility of “America’s Best Idea”. *Annals of the Association of American Geographers*, 103(3), 437-464. <https://doi.org/10.1080/00045608.2012.689240>
71. Westley, F. R., Tjornbo, O., Schultz, L., Olsson, P., Folke, C., Crona, B., & Bodin, O. (2013). A theory of transformative agency in linked social-ecological systems. *Ecol Soc*, 18.
72. WHC. (2020). Cocos Island National Park. <https://whc.unesco.org/en/list/820/>
73. Yee, J. Y., Loc, H. H., Le Poh, Y., Vo-Thanh, T., & Park, E. (2021). Socio-geographical evaluation of ecosystem services in an ecotourism destination: PGIS application in Tram Chim National Park. Vietnam. *Journal of Environmental Management*, 291, 112656. <https://doi.org/10.1016/j.jenvman.2021.112656>
74. Zarzuela, M. M., Pernas, F. J. D., Calzón, S. M., Ortega, D. G., & Rodríguez, M. A. (2013). Educational tourism through a virtual reality platform. *Procedia Computer Science*, 25, 382-388. <https://doi.org/10.1016/j.procs.2013.11.047>
75. Zhang, J. F., & Wang, S. P. (2012). Application of Virtual Reality Technology for Emergency Evacuation in High-Rise Buildings. *En Applied Mechanics and Materials* (pp. 4941-4945). Trans Tech Publications Ltd. <https://doi.org/10.4028/www.scientific.net/amm.204-208.4941>
76. Zhang, J., Wall, G., Du, J. K., Gan, M. Y., & Nie, X. (1999). The travel patterns and travel distance of tourists to national parks in China. *Asia Pac. J. Tour. Res*, 4, 27-34. <https://doi.org/10.1080/10941669908722041>

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