ANALYSIS OF TOURISM SUSTAINABILITY IN THE FERNANDO DE NORONHA ARCHIPELAGO, BRAZIL

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ABSTRACT

Purpose: Analyses tourism sustainable development of Fernando de Noronha state district through usage of Tourism Sustainable Indicators System.

Theoretical framework: The systems of sustainability indicators emerged as an important analysis tool, allowing to infer about different dimensions that make up the reality of a place or activity, and assisting in the search for Sustainable Development.

Method: The methodology proceeds with an integrative outreach utilizing semi-structured, surveys and interviews about environmental, cultural, social, economical, touristic and institutional dimensions applied to public authorities, civic society and private initiative agents, that allow to imply the archipelago is placed among sustainable, partially sustainable and, as indicate some indicators, unsustainable.

Results and conclusion: The results achieved show the importance of a sustainable resource administration, considering essential the two protected areas in the island. Nevertheless, a warning need to be done: the harmful effects of population increase and high touristic flow present serious negative impacts to sensitive environment and rich biodiversity.

Research Implications: The research has local and global relevance, allowing us to infer that the archipelago is situated between sustainable, partially sustainable and, as some indicators indicate, unsustainable, and thus contributing to the planning towards sustainability.

Originality/value: The indicator system used has been adjusted to adapt to the island context. Islands present themselves as excellent opportunities for sustainability analysis, given their context of isolation.

Keywords: Sustainable Development, Sustainability Indicators, Tourism, Fernando de Noronha, Protected Areas.

ANÁLISE DA SUSTENTABILIDADE DO TURISMO NO ARQUIPÉLAGO DE FERNANDO DE NORONHA, BRASIL

RESUMO

Objetivo: Analisar a sustentabilidade do desenvolvimento do turismo no Distrito Estadual de Fernando de Noronha através da utilização do Sistema de Indicadores de Sustentabilidade do Turismo.

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Referencial teórico: Os sistemas de indicadores de sustentabilidade emergiram como uma importante ferramenta de análise, permitindo inferir sobre diferentes dimensões que compõem a realidade de um local ou atividade, e auxiliando na busca pelo desenvolvimento sustentável.

Método: A perspectiva metodológica contou com uma abordagem participativa, se utilizando de questionários e entrevistas semiestruturada, com representantes do poder público, da sociedade civil e da iniciativa privada, acerca das dimensões ambiental cultural, social, econômica, turística e institucional.

Resultados e conclusões: Os resultados obtidos apontam para a importância de uma gestão sustentável dos recursos, considerando como essencial as duas Unidades de Conservação da Ilha. Ainda assim, um alerta precisa estar claro, os efeitos nocivos do aumento populacional e do fluxo intenso do turismo têm apresentado sérios impactos negativos ao ambiente frágil e rico em biodiversidade.

Implicações da Pesquisa: A pesquisa possui relevância local e global, permitindo inferir que o arquipélago situa-se entre sustentável, parcialmente sustentável e, como sinaliza alguns indicadores, insustentável, e assim contribuindo com o planejamento em direção a sustentabilidade.

Originalidade/valor: O sistema de indicadores utilizado foi ajustado para se adaptar ao contexto insular. Ilhas se apresentam como excelentes oportunidades de análise da sustentabilidade, visto seu contexto de isolamento.

Palavras-chave: Desenvolvimento Sustentável, Indicadores de Sustentabilidade, Turismo, Fernando de Noronha, Unidades de Conservação.

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1 INTRODUCTION

The archipelago of Fernando de Noronha (FN) is a tourist destination already consolidated in Northeastern Brazil, being considered national heritage of humanity. The tourist activity on the site started in the late 1960s, intensifying over the years through an increasing annual number of visitors. However, it happens that the place is home to a delicate ecosystem, being the only Brazilian island group to experience such a long and vast human occupation (Pine, 2019), which may have serious environmental and social impacts and may jeopardize the sustainability of the activity.

In this context, a set of actions have been developed over the years, such as the creation of two Conservation Units (UCs): the Fernando de Noronha Marine National Park (PARNAMAR-FN) and the Environmental Protection Area of Fernando de Noronha - Rocas - São Pedro and São Paulo (APA-FN). In addition, several standards have been created and are supervised by the FN State District Administration and the Chico Mendes Institute for Biodiversity Conservation (ICMBio) (Sazima, et al. 2013).

Historically, tourist activity in Brazil has intensified due to natural beauty and pleasant tropical climate, being present in the most remote places, bringing great contributions to socioeconomic development. Given this scenario, understanding how tourism has developed on the spot and the level of sustainability is essential.

Sustainability indicator systems have emerged from the need to analyze sustainability in different areas and areas. And, according to Ruggieri & Calò (2018), the islands correspond to the best cases of study in the analysis of positive and negative aspects linked to development based on tourism.

This article aims to analyze the sustainability of the development of Tourism in the State District of FN, through the use of the System of Indicators of Sustainability of Tourism
(SISDTur), with participatory approach, through the application of questionnaires and interviews with representatives of public authorities, civil society and private initiative, about the environmental dimensions cultural, social, economic, tourist and institutional.

The research also presents theoretical contributions to the applicability of the SISDTur when used in an island tourist destination, different from the context of the creation of the model, implying, locally, a diagnosis of the developed tourist activity, and generally, an expansion of the applicability of a model for assessing the sustainability of the development of tourism.

2 THEORETICAL FRAME

2.1 Impact of Tourism on the Oceanic Islands

Island economies usually have their bases in tourism and related areas, so the activity is configured as the main source of employment and income, characterizing itself as a means of development and growth (Ruggieri & Calo, 2018). However, the reduced territorial extent also implies a dependence on tourism, and a small market for domestic products, which leads to a dependence on exports, high costs for transport and great openness to international trade (Ruggieri & Calo, 2018; Pinheiro, 2019). Despite boosting growth, improving local infrastructure and facilities, tourism promotes a change in social dynamics, triggering often unfavorable cultural changes, in addition to impacts on the environment (Ruggieri & Calo, 2018; Wijaya et al., 2021), so that, precisely because they are limited environments, tourism development can have serious consequences (Tischer et al., 2018), with its isolation context being the main weakness of these sites (Sazima et al., 2013) (2).

In this sense, it becomes essential to monitor such impacts, given their characteristics: on the one hand their importance for many economies, above all island environments, which are characterized by few other economic activities (Ruggieri & Calo, 2018), and on the other, their ease in being disturbed by the presence of man, and may have their environments unbalanced (Sazima et al., 2013).

The geographical barrier allows the generation of new species, such as in the archipelagos of FN, Galapagos and Hawaii, which have different genera of plants and insects, which originated from populations of a single invasive species (Primack & Rodrigues, 2021). In addition, in these locations, as a result of geographical changes and the evolutionary process of the landscape, unique scenarios can be formed, with splendid creatures populating its waters (Sazima, et al. 2013).

In the FN Archipelago, the rotating dolphin (Stenella longirostris) turns out to be a species that contributes to awareness about nature conservation. According to Silva Jr. (2010), the habits of carrying out air activities and accompanying the vessels that chase the large groups, on the part of these animals, made them one of the main tourist attractions and an important source of income for the population. And the region is known as one of the best sites for observation of this species (Tischer et al., 2018).

The creation of UCs can contribute to the conservation of unique species, and many national parks have been created with the aim of protecting the "charismatic megafauna", which, besides captivating visitors, has great value for ecotourism, helping in the awareness and conservation of their habitats and other local communities, and may encompass thousands of other species (Primack & Rodrigues, 2021).

With the great interest for tourist activities at sea, the preservation of the sustainability of maritime areas demands a greater concern for conservation and biodiversity (Wijaya et al., 2021). The history of initiatives for the conservation of the sea shows that these areas were
much less prioritized than land conservation, so that the first Marine National Park was only created in 1983, in Abrolhos (Primack & Rodrigues, 2021).

Considering that tourism activity can contribute to the marginalization of the community and cause great impacts on society and the environment, the trend of tourism has changed in the world, underlining the importance of considering other areas besides economic growth, and influencing a paradigm shift in the management of the activity (Wijaya et al., 2021).

2.2 Sustainable Development Indicators

The use of sustainability indicator systems can help in the identification of social and environmental problems, allowing a better management and development of the activity, through the generation of diagnoses, monitoring, and follow-ups based on predefined goals (Oliveira, 2020). These models seek to identify the meanings of sustainability, through indicators that seek to reflect and measure, as objectively as possible, the sustainability of the development processes (Hanai & Espíndola, 2011).

According to Ruggieri & Calò (2018), with regard to sustainable development, it is necessary to consider an approach based on qualitative and quantitative indicators, as well as paying attention to the preservation and valorization of local resources, in order to achieve optimal development and contain the negative effects of tourist flows and the transport capacity of the sites.

Two methodological paradigms are pointed out in the analysis of sustainability indicators: the Top-Down, which usually uses, in an explicit way, quantitative indicators, which are collected rigorously, with expert evaluation through statistical tools, but excludes local communities; and the Bottom-Up, which has its basis in a participatory philosophy, being derived from systemic methods, and focusing on understanding the local context (Reed et al., 2006).

As both paradigms have their potential and limitations, the need to integrate them has been observed. And, according to Bell & Morse (2008), due to the immense boundaries of sustainability, a number of indicators are often needed, being grouped in various ways according to the dimensions and elements of sustainability that are intended to be assessed.

Research on tourism requires an organizational structure that considers the different ways of understanding such activity, and for this it is necessary to adopt a multidisciplinary or interdisciplinary approach, integrating different themes and disciplines (Cooper et al., 2007).

The different systems of indicators that have been adapted or created for tourism analysis allow us to better understand how tourism activity has developed in different destinations. In addition to producing a diagnosis of the location or activity, sustainability indicator systems help to preserve natural and cultural attractions for future generations, generating subsidies for better management.

2.3 Tourism Sustainability Indicators (Sisdtur) in the Fernando de Noronha Archipelago

Developed in 2009 by Yuri Hanai, SISDTur aimed to subsidize the process of development, management and monitoring of tourism in the region of Bueno Brandão - MG, according to the principles of sustainability. The model has already been replicated by several authors in Brazil (Silva & Cândido, 2016; Coelho et al., 2017; Santos & Cândido, 2018; Nunes & Nunes, 2019; Lacerda & Mecca, 2020; Santos et al., 2020), in different ways, and in different socioecological environments.

The system is considered by many authors as the most complete because it includes a wide range of dimensions of sustainability (environmental, cultural, social, economic, tourist
and institutional), using a participatory approach, including representatives of groups involved with tourism (Santos & Cândido, 2018; Santos et al., 2020).

The present study made adaptations to this model, in order to adapt the set of indicators to the peculiar characteristics of the study site, since it is an island region. In this way, a set of 75 indicators was considered, adapting the specific parameters, units of measurement and form of measurement.

3 METHODOLOGY

3.1 Field of Study

Located in the Atlantic Ocean, about 345 km away from Natal/RN, the closest point on the continent, the FN Archipelago has a main island and about 16 secondary islands (Silva Jr., 2010), being a State District belonging to Pernambuco, Brazil, under the institution of Law No. 11.304, of December 28, 1995, constituting a geoeconomic, social and cultural region of the state.

Figure 1 - Map of the Fernando de Noronha Archipelago
Source: prepared by Marília Teixeira for this article

It is classified as a World Natural Heritage Site by the United Nations Educational, Scientific and Cultural Organization (UNESCO) because of its significant biological importance and unique characteristics, being an oceanic archipelago of volcanic origin (Körössy et al., 2008). In this sense, two UCs were created: the PARNAMAR-FN (Decree No. 96.693, of September 14, 1988), and the APA-FN (Decree No. 92.755, of June 5, 1986), covering land and marine space.

The APA portion is bounded by the coordinates - latitude 03º45' S to 03º57' S and longitude 032º19' W to 032º41' W (Brazil, 1986), corresponding to about 50% of the main island of the archipelago. And the area of PARNAMAR has as coordinates latitude 3°45' S to 3°56' S and longitude 32°20' W, located in the Brazilian Territorial Sea (Brazil, 1988), comprising the other 50% of the main island, the secondary islands and the marine part.
The main economic activity developed on the site is tourism and, as noted in the flowchart presented by the Migratory Control, belonging to the administration of the island, there was a growth of about 21% from 2017 to 2021, and this increase has been constant over the years.

3.2 Research Characterization

This article used a multi-method approach, in which quantitative and qualitative data were triangulated to bring more consistency to the results. According to Yin (2001), triangulation is the logical basis for using different data sources.

The study employed a methodology of exploratory and descriptive nature, with a qualitative-quantitative approach and non-probabilistic sampling, using a semi-structured interview, with the main purpose of surveying the first subjects, and a survey questionnaire, which made use of the Likert Scale for quantifying the data, considering the perception of the participants of the survey as to the degree of agreement about the subject studied. In addition to quantification, a qualitative analysis was performed, using primary and secondary data sources, and non-participant observation.

The questionnaire was based on the one proposed by Hanai (2009), and the script for a semi-structured interview to identify the first research subjects followed the one proposed by Santos (2013) and Santos & Cândido (2018). Data collection took place in person, in the period from June 13 to July 6, 2022, and by virtual means, comprising a total of 48 respondents.

The data analysis was carried out by means of the Excel and Statistical Package for Social Science (SPSS) software, which made it possible to construct tables and graphs, using mean, standard deviation and coefficient of variation. In this way, the indicators were analyzed individually, being classified according to calculations based on Martins & Cândido (2012), considering formulas that help in the recognition of relationships, allowing the analysis of sustainability by aggregation, as calculation below:

\[
I = \frac{(X - X_{\text{min}})}{(X_{\text{max}} - X_{\text{min}})}
\]

Where:

- \( I \) = Indicator
- \( X \) = Average of indicator
- \( X_{\text{min}} \) = Minimum score assigned
- \( X_{\text{max}} \) = Maximum score assigned

Thus, the indicators were classified as unsustainable, when the assigned value was in the range of 0 to 0.300; partially sustainable, when the result was in the range of 0.301 to 0.700; and sustainable, when this value occupied the range of 0.701 to 1.00.

3.3 Characterization of the Subjects of Research

The subjects of this research represent a sample of groups representing public power, civil society and private enterprise coming, in the majority, from the state of Pernambuco (68%) and Rio Grande do Norte: 64.58% were female and 35.42% were male, with an average age of 51 years. A considerable percentage of respondents, 39.58% reported receiving more than R $ 7,700.01.
Figure 1 - Research subjects
Source: drafted by the authors

4 RESULTS AND DISCUSSIONS

The results obtained with the application of the SISDtur in the FN Archipelago are presented in this section, with an indication of the level of sustainability of the development of tourism activity by dimensions, from the perspective of the social actors that comprise the tourist trade.

4.1 The Environmental Dimension

The environmental dimension consists of twenty-three indicators. It was observed that, in a good number of the indicators, the Environmental Dimension is regarded as partially sustainable or sustainable, demonstrating that the activity has impacted the environment, albeit in a reduced proportion.

In 2008, a study conducted by Körössy et al. (2008) in FN indicated that demand for water varies according to the period of the year, so that it reached 40 m³/h in periods of high season such as December and January. A high production compared to the 24 m³/h demanded in the low season. It is important to consider that, the number of inhabitants in the archipelago has grown substantially in recent years, as well as the tourist flow.

Considering such data, the amount of water consumed by tourists can affect the local distribution, and, according to the research subjects, in FN, often came to lack water, reinforcing that this occurs mainly in periods of great tourist flow. However, after the expansion of the water desalination system, this problem appears to have become less frequent, and this indicator pointed to partial sustainability.

Since it is an island, the water supply of the Archipelago is through the capture of rainwater, some underground water sources, surface waters and desalination of seawater, being the responsibility of the Pernambuco Sanitation Company, both water supply, and sewage collection and treatment (Körössy et al., 2008).

It has been observed that in FN it is not common programs of reduction, consumption, waste and reuse of water linked to the public sector. Some private institutions take their own actions to this end. Such programs to reduce water consumption and reuse can enable a considerable amount of water to be saved, with the potential for a greater range, if it were
expanded and had a larger portion of the island adhere. In this sense, both indicators were pointed out as partly sustainable.

It is important to point out that during periods of greater tourist flow, the quantity of solid waste generated can cause serious local impacts, impairing the efficiency of the company responsible for the collection. Therefore, since 2017, the Program Play Clean with Noronha promotes actions in favor of reuse, like cooking oil, so that bars, restaurants and some inns receive containers for storage and are delivered to the company ASA Industria e Comercio Ltda, in Recife. And the Zero Plastic Program is working on reducing the entrance of plastic into the Archipelago.

![Figure 3](image)

**Figure 3** - (A) Separation and compaction of garbage collected in FN; (B) Program poster; (C) Dissemination of the Noronha Carbon Zero Program; (D) Program Selective Collection Calendar Play Clean with Noronha. **Source:** Personal archive.

The selective collection of solid waste is carried out by the Universe company, which is working in partnership with the administration of the island, represented by the Management and Environment department, carrying out the recycling, at the Solid Waste Treatment Plant, of part of the material, and the forwarding of the rest of the waste, in a compact form, to the continent, with the intention of promoting an adequate disposal of the waste produced on the island. Another relevant point was the creation and distribution of a calendar and pamphlet with information about the dates of selective collection for the inhabitants, an action of the Clean Play with Noronha Program.

AS for energy consumption, 47% of respondents agree that energy consumed by tourists affects local distribution. Some research subjects pointed to the expansion of the plant’s production as responsible for the improvement of the island’s energy picture, so that power outages were frequent in the past, no longer being a common reality. The programs for reducing energy consumption have been more directed towards the variation of prices in the amount charged to consumers, by means of the flag pointed out in the energy bills. Furthermore, FN has four solar power plants, and, according to the interviewee P2, a representative of the Department of Management and Environment, "in the new District Housing Policy it was asked that the community come with a solar energy project, and with these measures, it is now going to reduce the consumption of energy produced by oil".

It is also worth pointing out that a good part of the energy produced in the Archipelago is through the combustion of Diesel, by the Pernambuco Sanitation Company (COMPESA). Many developments have solar energy plates, but these usually generate a reduced amount of energy, and in many guesthouses these serve only to heat the water.

In relation to the sewage treatment process, according to data from the Brazilian Institute of Geography and Statistics, in the last census (2010), 82.7% of the island had adequate...
sanitation. Currently, the archipelago has two sewage collecting stations, one located in the Boldró neighborhood, and another in the terminal of Praia do Cachorro. According to the research subject P2 "we still have neighborhoods that are septic tanks, which are not 100% supplied" (P2, 2022). The APA Management Plan, updated in 2017, provides that "No new accommodation facilities, lodges and or lodges will be authorized in the Urban Area until the conditions for improvement of the island's infrastructure are met" (p. 94).

The indicators relating to noise and visual pollution indicated partial sustainability. In the APA Management Plan, the maximum acceptable noise limit in FN is 75 dB, except in events with prior authorization from ICMBio. The use of loud sounds, or sound boxes in commonly used environments, is frequent. Likewise, the flow of vehicles on the main roads and the high occupation at some periods of the year were the motives of the interviewees’ complaints.

In relation to preserved areas, recovered or in the process of recovery, it is pertinent to observe the history through which the archipelago passed, having been strategic point during the second world war, prison, among others. In addition, tourism activity in the Archipelago began in the 1970s, intensifying each year. In this way, much of the island's vegetation was modified, leaving few areas with original vegetation.

As it is a space with two UCs, FN today has rules for the use of the land and zoning with priority areas for preservation and recovery. Decree 95,922, of April 14, 1988 was responsible for zoning in favor of ecological defense of the federal territory in the Archipelago, determining the division of the space into Ecological Preservation Areas (EAPs), Ecological Conservation Areas (EACs), Ecological Restoration Area (ART) and Area of Use and Occupation (AUO). This indicator was considered as sustainable by the research subjects.

Air quality was pointed out as partly sustainable, so many felt that targeted programs were unnecessary. The main pollutants of the air are the production of energy from the burning of diesel oil and daily flights. It so happens that there is a lot of wind circulation in the FN Archipelago, and pollution does not become so noticeable.

Another point is the Noronha Carbon Zero Program, aimed at reducing the emission of pollutants arising from the use of vehicles on the island, with the planning of replacing the whole fleet by 2050, as the latest update. According to IBGE data, FN had a fleet of 1,448 vehicles in 2021 (IBGE, 2022), having increased by about 54% since the Support Capacity Study conducted in 2007. And this study pointed to a 600 percent increase from 1990 to 2007, so current data shows how that number has been growing.

In addition to automotive transport, aircraft have a major contribution to environmental degradation and air pollution, given the high levels of CO2 produced. According to Feitosa & Gómez (2013), the use of air transport to access the Archipelago throughout 2011 produced an amount of CO2 from burning fossil fuels that would require 14.5872 hectares of land, a worrying result when dealing with an island territory with only 1,700 hectares of extension.

In relation to the existence of an oriented program of environmental and cultural interpretation and education, according to the Management Plan of the APA-FN, favoring conditions for the promotion of education, environmental interpretation and recreation in activities in contact with nature is essential for the fulfillment of the objectives of the National System of Conservation Units and of the APA.

Thus, one of the activities proposed for the Public Use Program, provided for in the APA Management Plan, is the stimulation and support of ATDEFN to institutions that promote the training of the population in tourism, like the Brazilian Service of Support to Micro and Small Companies (SEBRAE), the National Service of Commercial Learning (SENAC) and some Non Governmental Organizations (NGOs).

In addition, there are specific actions of institutions, such as the Rotator Dolphin Project, which promotes courses of formation of Visitor Conductors in Ecotourism in UCs, based on
the minimum desirable content laid down in the normative instruction ICMBio n° 8, of September 18, 2008, as a premise for registration as a visitor conductor in the Archipelago (Pereira et al., 2015). Similarly, the environmental and/or tourist certification process for companies takes place on an ad hoc basis. Some inns visited during the data collection had, exposed on their walls, certificates acquired during the realization of events, such as Onda Sustentável 2021, organized by the FN Administration with the support of the private initiative, which issued plates with quality seals for establishments that meet the sustainability criteria. A division that has been made, but that is outdated, was the matrix of classification of inns in 1 Dolphin, 2 Dolphins and 3 Dolphins, according to the quality standard of each one, must meet infrastructure standards, accessibility and environmental requirements (Marine, 2014).

Figure 4 - (A) Certified in hostels and awarded during event; (B) Ground crab (Johngarthia lagostoma)
Source: Personal archive.

As for the initiatives implementing Agenda 21 and the sustainable development plan, it is foreseen in the activities of the Awareness, Awareness and Environmental Education Program of the APA Management Plan (2017), so this indicator culminated in a partially sustainable result, since many respondents demonstrated not knowing what this agenda was about, those who understood the subject indicated not to see targeted actions.

Fernando de Noronha has specific administrative organizational structures of environmental management, like the Superintendence of Environment. Administratively, the site is divided between the Government of the State of Pernambuco, through the Administration of the State District of Fernando de Noronha (ADEFN); the command of the Brazilian Air Force; and the ICMBio.

In addition to this organizational structure, other bodies, institutions and entities are active in the decision-making processes on environmental issues as well as tourism resolutions. The APA Area is administered by the government, the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) and, in part, under the command of the Air Force; and the Park area is under the command of ICMBio and IBAMA (Cristiano et al., 2020).

With regard to fauna, it can be observed that tourist activity may impact several species, so this indicator indicated partial sustainability. One species that is often heavily impacted by tourism is the Rotator Dolphin, *Stenella longirostris*, which suffers severe impacts from cetacean watching activities. The work of institutions with the Rotator Dolphin Project is of extreme importance in the conservation of animal species, as well as the Tamar Project and the Noronha Birds Project.

It is worth mentioning that the Tamar and Rotator Dolphin Projects are cited in the management plan as institutions that contribute to environmental education, management,
conservation and research in the Archipelago, these being of great importance in the path in search of sustainability.

Actions in favor of the conservation of endemic species are carried out in different areas. The ban on the capture of the land crab, *Johnsgarthia lagostoma*, was the result of intense pressure of poaching by the islanders in the APA area, leading to a level of vulnerability and threat of extinction (ICMBio, 2017).

The Archipelago still houses endemic species of corals, which according to the APA Management Plan, of the corals species existing in Brazil ten are present in FN: reptiles, like the two-headed snake (*Amphisbaena ridleyi*), the small lizard (*Trachylepsis atlantica*), the mabuia (*euprepiris atlanticus*); and the species of flora, like the gameleira (*Ficus noronhae*), and the dairy burra (*Sapium sclay*), *among others*.

### 4.2 Cultural Dimension

With the exception of the indicator "There is a significant amount of heritage, architectural, archeological and historical property", which was considered Sustainable, all other four indicators were pointed out as partially sustainable.

It was observed that a good part of the souvenirs offered in the Archipelago are not of local origin, being produced in the mainland and marketed in strategic points of the main island. However, the region has a significant number of artisans, many of them being registered in the Association of FN Plastic Artists and Fair Representatives. Some of the products produced on the island make use of recyclable materials, thus reinforcing a culture of conscious consumption and reuse, while other products require materials from the mainland.

Considering the history of FN, there is a diversity of constructions that make up the arsenal of local history, with forts, ruins, prison, churches. Although this indicator was considered sustainable, many respondents pointed to the conservation of these constructions as a problem. It is noticeable that some buildings that are part of the island's history, such as the former Hotel Esmeralda and the igloos used by the Americans in the war period, are today used as lodgings, but seem forgotten in the archipelago's past, without maintenance and without integration to the local tourist routes.

According to the APA Management Plan, it comprises the Historical-Cultural Zone of FN, the buildings listed by the Institute of National Historical and Artistic Heritage (IPHAN), with the objective of rescuing, restoring and protecting the historical-cultural and archeological heritage, strengthening the cultural identity and diversifying the visitation route, while considering the environment and promoting the citizenship and protection of traditional spaces.

The archipelago has some traditional folk events and festivities and typical cultural manifestations during the year that are already part of the island's calendar. During the data collection, it was possible to follow, for example, the Feast of St. Peter and the traditional cockroach that takes place in commemoration of this date. Other events mentioned by the research subjects were the Juninas festivities, Feast of the Patroness of Our Lady of Remedies, and the traditional carnival and New Year's Eve festivities.
Figure 5 - (A) Barqueata in commemoration of the feasts of St. Peter; (B) Festivities in commemoration of St. Peter's Day

Source: Personal archive.

The existing registers of bodies, institutions and artists of traditional culture are limited to the lists of associations, and there is no apparent registration with public institutions. And as for the rescue, promotion and maintenance of traditional culture, a name often cited throughout the application of the questionnaires and interviews was that of Dona Pituca, who, according to the islanders, had great contributions to the promotion and maintenance of the culture of FN, dedicating her life to the conservation of local culture. Many indicated that, after his departure, there was no figure so strong as to be able to continue the actions in favor of traditional culture at the same level, so that much of what was done has been lost.

4.3 The Social Dimension

With nine indicators, this dimension was distributed between sustainable or partially sustainable, with the exception of the indicator referring to the increase in tourist flow and its influence on the resident population of the island, which was analyzed as unsustainable.

Considering that tourism is the largest income generator for the resident population, it is observed, and it was confirmed by a significant number of respondents, that there are a significant number of residents employed in the tourist establishments.

In this sense, courses are usually offered to residents, by government and institutional initiatives, in order to train and offer professional training to the population. In addition to government initiatives, which seek support in education and entrepreneurship companies such as SEBRAE and SENAC, local institutions have been active in the training and training of islanders for many years, one example being the language courses and driver training offered by the Rotator Dolphin Project. In this way, there are a significant number of resident employees with training in tourism, both in public and private companies, as well as acting autonomously.

In the tourism department of the Archipelago Administration, two employees have a degree in Tourism, and some of the respondents to the questionnaires were tourists acting in the management of lodging facilities or other ventures.

As for the question whether the number of fixed jobs in tourism is higher than the number of temporary jobs, a partially sustainable result has been achieved. Therefore, considering the need for a housing permit to live in FN, new inhabitants usually get a temporary visa when they are called to work in the archipelago. The site has well-established tourism activities, being classified by the Ministry of Tourism as an inducing tourist destination, with a rate of dependence on tourism of 61.2%, and with 65% of its establishments in the tourism area.
According to the support capacity study carried out on the island (ICMBio, 2009), up to that time there were a total of 1,066 people employed in tourism, with a percentage of about 50% of fixed jobs in tourism firms.

It was also observed that there are a large number of owners and entrepreneurs of tourist establishments of local origin, even because these people are the holders of the land use right, according to District Decree No. 006/2020 and Law No. 11.304, of December 28, 1995.

In some periods of the year there is a peak of occupation on the island, both of residents, and of tourists, with emphasis on the period near the New Year's Eve festivity. According to the IBGE, the estimated population of FN in 2021 was 3,140 people. The APA Management Plan estimates that the site has an average population load of 4,000 people, so the island operates with overload, this being estimated at about 1,450 people beyond the local support capacity. Similarly, the tourist flow has increased each year in the Archipelago, so that in 2021 the island received 114,106 tourists.

With the increase in tourist flow, the population tends to grow, since the supply of jobs to meet the demand also rises, leading to unsustainability in terms of this indicator and the control of local support capacity. Population growth and tourist flows tend to be the main aggravating factors for unsustainable destinations, requiring rapid action. The increase in the number of tourists, although it generates economic benefits, can bring numerous harms to the environment and living standards to the population, leading to a level of dissatisfaction with tourism.

The existence of social programs and projects involving the population and linked to the development of tourism was another point questioned, obtaining partially sustainable result and demonstrating the need for inclusion of the population in the process of tourism development, not only as executors, but also in decision-making processes.

### 4.4 Economic Dimension

The Economic Dimension was composed of eight indicators, with 50% analyzed as partially sustainable and 50% as sustainable. The economic benefits of tourism for FN are evident, so that tourism activity generates a considerable percentage of income for the population.

In the same way, the establishments, show high longevity, even by the impossibility of passing on the right to use the land. In the APA area it is possible to observe lodges that have existed for decades, having passed through different historical periods.

Due to the high prices of services and products, the average daily spending of tourists in tourist establishments is usually significant, so that the destination is not usually accessible to all audiences. One of the justifications is the difficulty in accessing the raw materials for the production of many items offered, the cost of transport, since everything needs to come from the continent, among others. Likewise, the profile of the visitor, according to the study of the island's support capacity, carried out in 2007, indicated an income above 11 minimum wages (54.4% of the visitors).

The indicator referring to the considerable annual government investments in tourism indicated a partially sustainable outcome, as well as the considerable investments of tourist establishments. It so happens that, because the place has tourism as a hegemonic economic activity, many respondents considered that there should be more investments in the sector, mainly public. However, a good number of the research subjects who were members of the private enterprise group considered that they invested heavily in improvements to their establishments.

The proportion between the value raised by the tourist activity and the estimated value of the public investment in tourism in the year achieved a partially sustainable result. Private
companies and tourists pay an Environmental Preservation Fee (TPA), which is used to maintain the ecological and environmental conditions of the island, being this fee, proportional to the stay time of the tourist (Cristiano et al., 2020), in addition to tickets that allow access to PARNAMAR.

As for strategic programs and initiatives to minimize the seasonal nature of tourism, a partially sustainable result has been achieved, since the period of the smallest occupation of the island is short, and there is great occupation for almost the whole year, so that such initiatives are not much needed.

The indicator emergence of new establishments, enterprises and tourist products in the year achieved a sustainable result. Being in the economic dimension, this emergence of new companies is seen as something positive, although considering the supporting capacity of the island, it can bring negative environmental impacts when analyzed in other dimensions.

4.5 Tourist Dimension

The Tourist Dimension had eighteen indicators.

The data collection allowed to infer that the total offers of accommodation, food establishments and agencies and receptive services are considered sufficient to meet the tourist demand. And, according to the APA’s Management Plan, the set of means of hosting FN makes up the largest economic activity carried out, both in number of people attended, and in financial resources involved, being the area that there is the most involvement of the inhabitants, importing of labor and impacts on the environment.

According to the FN Support Capacity Study (2009), until 2008, the site had 110 establishments classified as hotels and hostels, with 1,650 beds. It so happens that it is noticeable that many new establishments have emerged in recent years. Likewise, there are hosting facilities that operate irregularly. Recently, the FN Inns Association split up, giving rise to the FN Household Association, welcoming the new developments that have arisen, and encouraging the transformation of residences into alternative accommodation means.

As for the supply of transport services and their sufficiency in meeting the tourist demand, despite FN having today a number of 1,663 vehicles, according to data from IBGE (2023), the evaluations made by the respondents culminated in a partially sustainable result of this dimension. This is due to the public transport available, since two minibuses usually circulate on the roads, commonly simultaneously, not being often enough to serve the population and tourists, who share this option. In addition to public transportation, the island has taxi and car rental options.

Figure 6 - (A) Public transport in Fernando de Noronha; (B) Sunshades on the Beach.
Source: Personal archive.
With regard to the existence of facilities for mobility of people with difficulty of travel or other special needs, despite the existence of structures for access to tourist spots, such as the Mirante of the Bay of Dolphin and the Bay of Sancho, and for some beaches, many tourist spots are difficult to access for wheelchair users and people with other needs, like the main cultural tourist spots, located in the vicinity of Vila dos Remédios (Church of Our Lady of Remedies, Fort of Our Lady of Remedies and Palace São Miguel), being this indicator pointed out as partially sustainable.

Currently, the main tool for registration and visitation control is the Environmental Preservation Fee (APT). The administration of the island also has a migratory sector, which manages the entries and authorizations to remain in place.

Some attractions have guided tour programming with cultural or environmental interpretation, most commonly these are part of PARNAMAR and are managed by ICMBio. In addition, the park has a permit contract to provide the support service around public visitation and ticket collection, through the EcoNoronha Company, through bidding process, aiming at sustainability and management of ecotourism, strengthening the relationship of the society with the UC through actions to improve the quality of life (Cristiano et al., 2020).

On the carrying capacity of tourist attractions by enterprises and tourists, it is important to point out that the current study of support capacity is from 2008, and there has been a great increase in the flow of tourists, resident population and constructions in recent years, being vital the follow-up and update of this document.

As to the proportionality between the number of drivers/guides and tourists, a partial sustainability was observed, so that there are many professionals working, but there is also a need for new training courses and retraining of those already working in the area.

The indicator referring to the low frequency of occurrence of incidents and accidents, such as theft, theft and violence, involving tourists in the year, was considered sustainable. The public data available report the low incidence of assaults and crimes of violence in the place. However, according to some researchers, thefts are more common.

And, at the height of the discussions about the problem of the incidents with sharks that occurred in the Southeast Beach, the indicator "the island shows itself prepared to attend to the occurrence of incidents with sharks or other animals" was considered unsustainable by the respondents. During the data collection, it was possible to follow the District Meeting and the Tourism Council on the reopening of Praia do Sueste, in the auditorium of the ICMBio, in FN, held on June 28, 2022. This event presented the actions made, among them the new contacts of SOS, the implementation of new warning signs regarding the presence of sharks on all beaches, cameras, improvement of the first aid kits, investments in research, changes in diving standards and production of video awareness specifying the area of the beach where diving is allowed.

According to Silva & Nascimento (2019), no cases of shark attacks on humans have been officially recorded in FN until 2015, so experts point to the growth in the number of tourists and surfers as the possible reason for the increase in incidents with these animals. The problem related to Praia do Sueste intensified, causing the closure of the beach, from the moment it was reported the incident with an 8-year-old girl in January 2022, which caused the amputation of her leg. In April 2022, another incident occurred involving a 34-year-old man, who was reported to have probably bumped into the animal at Cacimba Beach. Likewise, there are not enough lifeguards on beaches year-round according to respondents and observation during data collection.

However, in view of the attractions of the place, it was pointed out that many tourists are satisfied and return to the establishments and tourist site, and when they do not, one of the main justifications pointed out is the high cost of the trip. Many inns have regular customers, and a good rate of return.
The existence of facilities and structures to minimize the impacts of tourism divided the opinion of respondents, so as to classify it as partially sustainable. It is noted that in some places on the island, facilities have been built, like the suspended trails to access the Mirantes of the Bay of Dolphins and the Sancho. These structures avoid trampling the track, but at the same time, one must consider the damage of such constructions.

Since it is an island region and has a clear predisposition for activities in nature, tourism is more focused on interactions with the environment, covering some segments and activities that revolve around it. Thus, the existence of a diversification of tourism resources and the attractions and activities developed, were not considered fully sustainable. The site itself is limited to other segments of tourism. Some of the activities and attractions sought are tourism for observing the fauna, hiking, diving, surfing, boat trips, beaches, historical buildings, among other activities allowed in the UCs.

There are Regulations and Norms for occupation and land use in tourist areas in FN. In addition to District Decree No. 006/2022, which brings the Housing Policy of the FN State District Municipality into line with Law 11.304/1995, several rules are established and supervised depending on whether the inhabited areas are located within an APA. To build any property, it is necessary to have a Land Use Permission Term (TPU). Likewise, for property changes and expansions, it is necessary to have the permission of the administration. Although there are such measures and the indicator has been pointed out as sustainable, the research subjects have reinforced the need for better supervision. Lack of adequate regulation and enforcement can lead to exploitation of natural resources, ecosystem degradation and marginalization of communities (ZAINAL et al., 2023).

One of the specific management objectives of APA, established in the Management Plan (2017), which is a priority of ICMBio, is the guarantee of the elaboration of a Master Plan and the legislation of use and occupation of the land, based on the guidelines that were established in the zoning of APA, as well as the capacity and infrastructure of the island.

4.6 Institutional Dimension

The institutional dimension had twelve indicators. The provision of training and specific technical support in tourism was one of the points to be considered as sustainable, reinforcing the existence of courses offered by institutions of the continent in partnership with the administration of the Archipelago, besides the local institutions that collaborate with the professionalization of the population to act in tourism and in line with the precepts of sustainability.

Entrepreneurs and administrative managers also have a stake in the tourism sector. It is worth noting that there are several associations that represent enterprises that make up the tourist trade: APFN, AHDFN, ABRENO, among others. Social participation was considered as partially sustainable, demonstrating that despite the other representative associations of class, like the Noronhense People's Assembly (PAN) and FN District Council (CDFN) there is still not enough representativeness of the population in the tourist development process.

The existence of mechanisms for communicating the results of decisions on tourism development divided the opinion of the respondents, with the lowest average being attributed by the representatives that make up the civil society group.

The archipelago does not have a Local Tourism Plan, but it is part of the Integrated Development Plan of Sustainable Tourism (PDITS) of the Costa dos Arrecifes Polo (2012), which, although outdated, meets the part of the indicator "there is integration of territorial planning and environmental management plans with tourism development".

In addition to the above-mentioned actions, such as events and certifications in favor of sustainability of tourism, education and awareness programs on sustainable tourism applied to the community are occasionally promoted, but not always by government institutions, demonstrating the importance of projects that work towards sustainability of FN.

Although there are several associations in the Archipelago, it is noticeable that they do not participate in meetings about the decision-making processes for tourism development. However, there are specific organizational and administrative structures in tourism, such as the Tourism Board and the Superintendence of Tourism, Culture and Sports.

In view of the dimensions covered, we have developed a graph that facilitates the visualization of all SISDtur indicators. The points that approached the outermost part of the graph (n=1) had a better assessment, approaching sustainability, while the points closest to the center (n=0) hung more towards unsustainability.

Figure 7: SISdtur Grouping Data Model by Dimensions
Source: Data collection (2022).

According to the Support Capacity Study prepared in 2007, the Environmental Vulnerability Index (EVI) of FN was estimated at 322, positioning it as a highly vulnerable environment, setting as priorities for intervention the number of introduced species; endemic species; endangered and/or vulnerable species; basic sanitation; population growth; the number of vehicles; and the number of tourists.

In this same study, the overall capacity of the island was defined as an estimate of 6,000 people. The IBGE census estimated the population of the island in 2021 at 3,140 people, although some islanders claim this number is much higher. The flow of tourists visiting the site has also grown each year, so that in 2021 it received 114,106 tourists, according to the annual flow chart publicly available by the Island’s Administration.

Many points present in the study of support capacity and other research carried out in the locality meet the results of this research, reinforcing the need for more effective actions in favor of limiting social and economic growth in the locality, seeking a sustainability of the activities developed.

7 CONCLUSION

The research showed that Fernando Noronha, in the majority of cases, permeates between partial and total sustainability, however, with some indicators already indicating
unsustainability. Considering that it is an environment that has two UCs and therefore limitations of use and enforcement, such results can be justified.

As observed, 6.66% of the indicators of this survey pointed out the unsustainability of the tourist development, and more than half of the indicators pointed to a partial sustainability, so that such data can serve as a warning for the need to direct management efforts with a greater focus on the reach of sustainability.

However, as a fragile environment with rich biodiversity and endemic species, it is essential to look for ways to ensure the sustainability of local development. The most damaging point for sustainability is population growth and increased tourism flow, which has a direct impact on support capacity.

Improving management techniques and intensifying inspection is essential, but not sufficient in the face of a growing population. The Archipelago has Management Plans of the UCs, Study of Support Capacity and legislations that assist in its management, as well as institutions that act in the supervision. However, such documents require updates, and a Master Plan is still expected.

The need for new studies to help update the data that make up the Support Capacity Study, as well as urgent measures to help control population growth and tourist flow, is also becoming evident.

In order to identify the level of sustainability of tourism activity, some adaptations were needed to the SISD'Tur methodology, which allowed, in addition to the direct contributions to the sustainability of tourism in FN, to provide theoretical contributions to the applicability of this methodology, implying locally a diagnosis of the tourism activity developed, and, in general, an expansion of the applicability of a model for assessing the sustainability of tourism development, since it is an island tourist destination.

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