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Artigo Científico

The Night Sky as a heritage of humanity and Astrotourism as a tourist potential in the rural regions of Rosana/SP.

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Abstract: This study presents a review of the literature on the interconnection between the quality of the night sky and the growing interest in astrotourism. As a basis for the data collection, studies of secondary documentary were used. It was observed that there is growing interest in the subject among academics considering the possibilities of astrotourism activity, due to the distinctive elements of the offer in the field of tourism, as well providing an element of fun and enjoyment, in the tourists' perception. The study is relevant in view of the small number of studies in Brazil on the subject and the possibility of incorporating this type of service in the national tourist sector, as well as the possibility of including astrotourism as a distinctive element of the offer in rural areas, as occurs in other countries.

Key words
Night Sky;
Astrotourism;
Light Pollution;
Rural Tourism;
Heritage.

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Introduction

Astrotourism is a niche with growing interest, both in the theoretical field and in terms of the potential, forms of offer, capacity to interconnect with other attractions, and promotion of tourist activity in locations outside the urban axis, among other aspects related to the understanding of the offer.

Municipal managers, individual entrepreneurs, especially in rural areas, and others interested in enhancing the offer of this type of service can benefit from this type of tourist arrangement, considering the low financial investment required, the attractiveness of the theme, and the fact that it can be directly linked to tourism offers, such as events, places, and properties, as well as indirectly, through complementary services providing accommodation or similar facilities.

It is observed that studies related to Astrotourism are still incipient, and a deeper understanding of the subject is needed, particularly bearing in mind the low supply in Brazil. However, other countries, including Portugal, the United States, Chile, Norway, and Russia, among others, are taking advantage of the potential of this type of service and have expanded their actions to implement places where this type of experience can be offered to tourists.

The emergence of a greater understanding of the subject is seen in the expansion of this type of offer in various countries where tourism is on the rise, or even the establishment of delineating landmarks of the offer.

This study discusses, in an introductory form, the importance of the night sky for the offer of Astrotourism in rural areas, based on the premise that this is an expanding market niche, and the possibility of structuring a system for operating this type of offer in Brazil.

Theoretical Framework

Night Sky

The night sky has been observed by humanity since the beginning of time, as man searches for answers to the primal questions of his origin and the origin of the universe (Tomanik & Bastos, 2012). Sky gazing is done with the naked eye or with amateur equipment, whether by lay persons or by specialists at scientific observation centers.

Based on the technological evolution, the reality of observing a completely dark sky, in most urban regions, is no longer possible. Often, to enjoy the natural landscapes and contemplate the night sky, one has to travel to places where the conditions more favorable for the enjoyment of this type of tourist offer. Thus, observation of the sky and its celestial bodies, together with the management of tourism, enables us to offer a service aimed at recreation and enjoyment of activities, at a time when consumers are seeking to travel to places away from where they live (Valladares, 2020).

Interest in astronomy as a consumer activity has led to the development of observatories around the world, which offer activities such as stargazing, watching eclipses, and visits, among others (Marujo & Fialho, 2021), in addition to several other activities offered in places with low light pollution combined with tourist facilities, generally in rural areas.

However, although the night sky is part of everyday reality, and a scientific interest of human beings, at all times, and in all societies, it has been suffering the consequences of light pollution (Tomanik & Bastos, 2012) which impairs observation of the sky, animal life, and even human life itself.

The Night Sky as heritage

The constant interaction with the sky, throughout the history of human civilizations, is a heritage of humanity, both in its natural and cultural aspects (Tomanik & Bastos, 2012). For this reason, its preservation can also be considered as a heritage of humanity, essential for the night sky, in which it is one of the objects of study of this article.

Therefore, attempts are made to revive this interest in observing celestial bodies and marveling at a clear sky in a natural landscape, in a way that promotes the learning of astronomy (Valladares, 2020), as well as scientific education, studies, and field activities that can promote sustainable tourism planning.

In 2021, in Brazil, a Bill 1975/21 was passed authorizing bodies of the National System of Nature Conservation Units [Sistema Nacional de Unidades de Conservação da Natureza – SNUC] to create programs to certify locations that have good potential for observing the night sky (Agência Câmara de Notícias, 2021). This will further strengthen the implementation of astrotourism in Brazil.

The project shares some similarities with international certifications, such as the International Dark Sky Places (IDSP) program led by the International Dark Sky Association, which is designed to encourage communities, natural parks and protected areas around the world to preserve and protect the night sky through responsible lighting policies and science education on the topic (IDA, 2021b).

Another project in this area is Starlight destinations – places characterized by an excellent quality of night sky, where tourists can look at the stars. The improvement in the quality of tourist experiences goes beyond discovering associated scientific, cultural, natural values; it also includes preservation of the sky (Starlight Foundation, 2021).

Light Pollution

Artificial light at night used by anthropogenic processes is a cause arising from the evolution of a society that, in recent decades, has been accompanied by the rapid pace of industrial development; a recent achievement compared to the history of humanity. Exposure to these light sources at night, where there was none before, came about mostly after the invention of the arc lamp (Owens et al., 2020).

Light pollution is generated by the excessive or inappropriate use of artificial light (IDA, 2021c), and can affect several components, such as the environment, human health, the economy of a place, science and education, and above all, the Astronomy (Araújo, 2017).

The International Astronomical Union states that light pollution is the incorrect use of artificial lighting outdoors. Moreover, it divides up the way the light pollution is presented into various modalities. The diffuse glow of the sky can be seen from long distances; this effect is caused by sources that emit light which is then dispersed in the particles of the atmosphere, including pollutants. Intrusive light is light that invades unwanted places. Glare, meanwhile, is a consequence of excessive brightness, which generates high contrasts at night, and can cause dazzling (IAU, 2015).

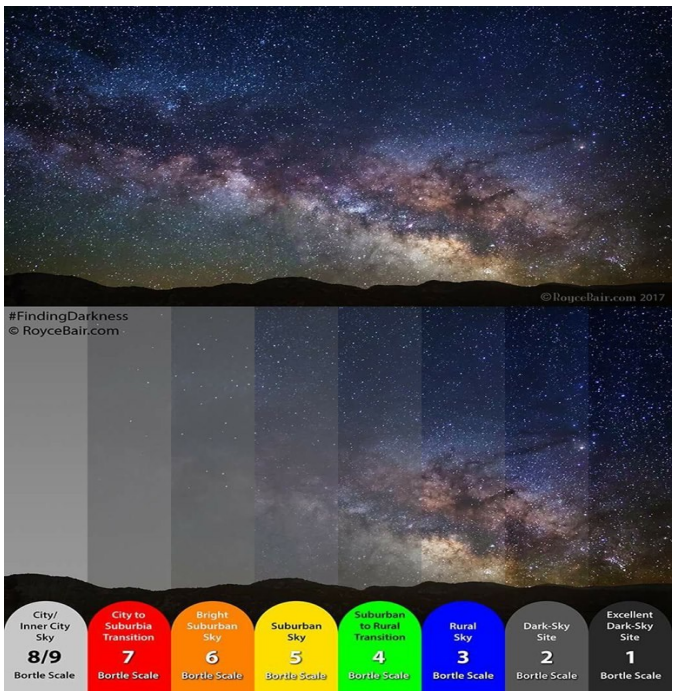
However, the natural human sensory perception has great difficulty in detecting the effects of this type of pollution, mainly because the damage caused tends to be noticed only over the long term (Araújo, 2017). This may be one of the reasons why, when problems do occur, the public bodies generally fail to implement satisfactory measures to the combat light pollution.

In general, to mitigate the consequences caused by light sources, some factors must be considered: their applicability, i.e. whether the object requires lighting, considering the impacts of its use; the protective structure, whether it directs light only to the planned location; the intensity; and the lighting control, preventing its dispersion, as well as additional energy dissipation when not in use. Another aspect to consider is the ideal color temperature, and it is desirable to restrict, as far as possible light emissions with a low wavelength, close to the color blue (IDA, 2021a).

That said, based on the lighting planning, the aim is for the visualization of photons, by an individual to be increased, as the quality of a starry sky also depends on the influence of light pollution in the atmosphere where the observing is done. The atmosphere is attenuated and contaminated by solid and gaseous pollutants, and by light, i.e. the less atmospheric interference there is from lighting, the greater the contrast between the brightness of the object and the brightness of the sky (Araújo, 2017). It is also important to demonstrate that the quality of the observation will depend on other factors, such as altitude and the weather.

Although we share the same sky, light pollution means that not everyone can have access to the same nightscape. Therefore, the Bortle Scale was developed as a consistent method for comparing observations of the night sky. It is divided into nine classes, making it possible to establish the difference between different observation points (Bortle, 2001), as shown in the diagram below:

Figure 1: Bortle Scale



Source: EXOSS Citizen Science Project

In addition to negatively influencing the visualization of stars, planets, and other stars, studies show that artificial light at night also affects the well-being of plants and animals, including insects, which are greatly affected, and which play such an essential role in the ecosystem that their extinction would have devastating consequences for the planet (Owens et al., 2020).

"Prolonged and uninterrupted exposure to light at night can have negative consequences for living beings, due to the change in the function of the biological clock and the production of melatonin" (Araújo, 2017), and it is considered as one of the probable carcinogenic agents of group 2A, by the World Health Organization.

Astrotourism as a practice with tourism potential in rural areas

Protecting the night sky has many benefits and potential for tourism development and planning. Thus, the concern with the night sky is part of sustainable deve-

lopment, and tourism is seen as one of the alternatives for promoting this heritage, provided it is done creatively and sustainably (Tomanik & Bastos, 2012). Thus, in protected areas and low-density territories, astronomical tourism has huge potential to satisfy the different curiosities of tourists or visitors in the area of astronomy (Marujo & Fialho, 2021).

Astrotourism, therefore, has significant potential in rural areas with low light incidence, which can be considered suitable for the implementation of this sustainable tourist activity by the rural owners themselves.

Astronomical observation and appreciation carried out in appropriate places for this purpose, whether in observatories or even outdoors, constitute a form of sustainable tourism and leisure, provided the local carrying capacities are respected, contributing to the preservation of the quality of the night sky (Tomanik & Bastos, 2012). In contrast to the above, tourist service providers, in particular, rarely include astronomical attractions in their tour packages, resulting in a lack of supply of products linked to this modality and a waste of this type of alternative (Valladares, 2020).

According to Dominici & Rangel (2017), the Ilha Grande archipelago has some tourist activities, such as fishing and the use of scientific research in the environmental area, which are being affected by light pollution caused by inappropriate lighting. The regulation, according to the same authors, would serve as a guide for companies and residents, promoting good practices in the use of light, and would complement actions to protect the recognized natural heritage of the Island.

Internationally, astrotourism is a well-known term, as many countries benefit from the strategic location of astronomical observatories. Such places are recognized, for example, in Chile, Argentina, Hawaii, the Canary Islands, Spain and many others (Valladares, 2020). In Chile, special infrastructure has been designed and built for the investigation of the cosmos, and are presented as a need for other places, to enable sky gazing by amateurs, including tourists wishing to find out more about the stars of the Southern Hemisphere (Sepúlveda; Palacios, 2020).

Thus, the activity of astrotourism, when practiced sustainably, promotes the preservation of the environment and culture, and the quality of the night sky for the observation of the stars and other celestial bodies (Tomanik & Bastos, 2012). The development of astrotourism in rural areas is being considered, and research is being carried out for its practice in a rural area of São Paulo, in the municipality of Rosana/SP.

Tourists are looking for genuine and different experiences, and astronomical tourism is a type of tourism that can meet these new demands (Marujo & Fialho, 2021). The rural space is one of the most viable places for this practice, and the municipality of Rosana/SP certainly has potential for rural tourism, with its natural beauties and attractions, diverse flora and fauna, and the meeting of the Paraná and Paranapanema Rivers, where São Paulo's ground zero is located.

The objective of astrotourism is profitability, but at the same time, it must safeguard the natural resources and respect the local populations (Valladares, 2020). Astronomical tourism is a relevant factor for the development of tourism in the municipality, benefiting from a clear night sky, as a natural resource that the local inhabitants, and especially rural properties, can take advantage of. Thus, the quality of the night sky can become a vector for tourism (Tomanik & Bastos, 2012).

In short, astrotourism is an activity that is emerging as a sustainable option for the socio-economic progress of territories and a catalyst for the economies of local communities (Araya-Pizarro, 2020). And in the wake of the COVID-19 pandemic, it could become one of the most popular types of alternative tourism. Therefore, according to that author, for the diversification of astrotourism to occur, it needs to cover a broad framework of tourist activities that, based on the culture of the sky and the stars, can come together to generate a tourist product that is valued in the communities where it is implemented.

Methodology

This study uses a theoretical basis that composes the specific themes of the research to conduct a qualitative analysis of the object of study. Lüdke; André (1986, p.257) point out that "the case is always well-defined, and its contours must be defined in the development of the study". This study, therefore, uses documentary research sources of a descriptive nature, in order to clearly delineate its main principles, in this case, astrotourism.

To obtain a certain precision, the study sets out the basic chapters that deal with the interaction between individuals and the night sky, such as its interpretation as an activity, conservation awareness, and light pollution, a determining factor for the quality of star gazing. From there, conjecturing about the possibility of implementing astrotourism as an activity becomes an object of planning that must be carried out, for it to become consolidated.

To analyze the light pollution index in the region, the Light Pollution Map tool was used, a website that shows the light intensity of a region by superimposing layers on a map. Some places of interest were listed, and their indices compared, seeking to identify the potential of the night sky in the municipality for astrotourism. The website uses data from the quantification performed by the VIIRS satellite, and also from the study of the World Atlas of Artificial Night Sky Brightness (Falchi, 2016).

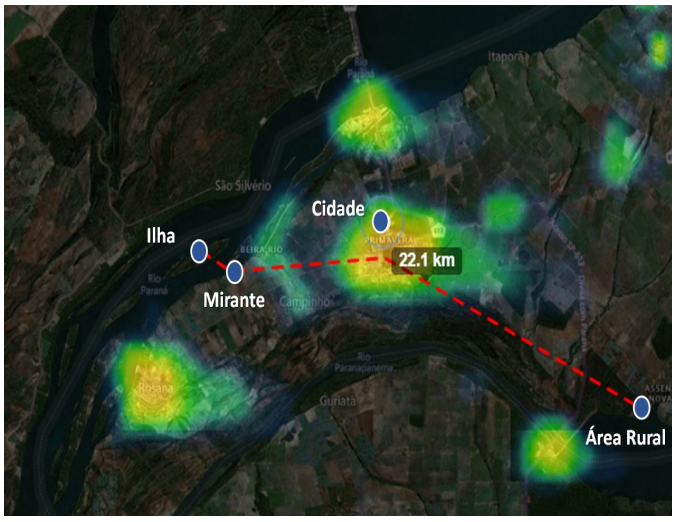
Data Analysis

At the outer edge of the state of São Paulo, 780 km from the capital, the municipality of Rosana is situated between two rivers; the Paraná and the Paranapanema, which enhance the municipality for tourist activities. Both nature tourism and rural tourism can be highlighted, with local settlements being encouraged to promote tourism as an additional source of income. Fishing tourism is also a predominant segment in the region, due to the presence of large bodies, and its proximity to the reservoir of the Rosana Hydroelectric Power Plant.

The town's Balneário Municipal provides a departure points for the boat trips that carry tourists to nearby islands, such as the Ilhas do Rio Paraná, with comprise sixteen islands located in near the Balneário de Rosana. On the banks of the Paraná River there is has a lookout (Mirante), built thirty-eight meters above the river bed (Secretary for Spot, Tourism and Culture, 2021).

The points of inference are the analyzed locations based on the light pollution generated in the region and its indicators. Thus, Figure 2 points to the locations of analysis:

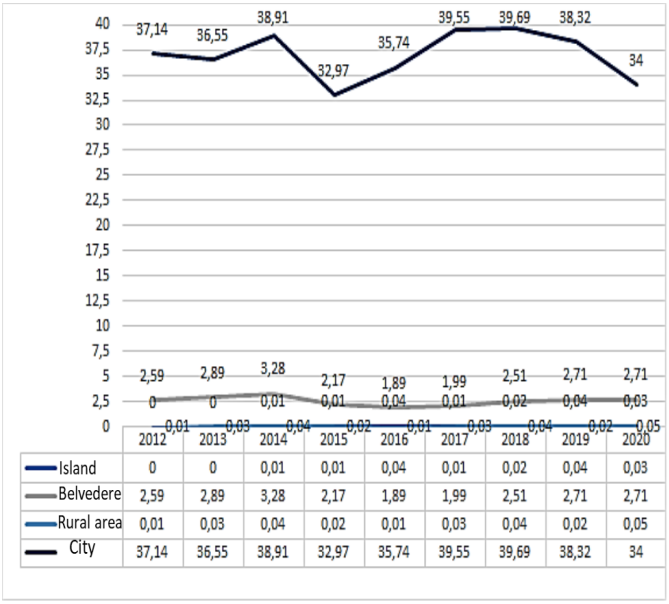
Figure 2: Indication of observation locations



Source: adapted from Light Pollution Map, 2021

It is observed that locations further away from the urban centers present a consistent difference in terms of light pollution, and that the alliance between the natural conditions of the localities, along with the potential to make use of the space for the introduction of Astrotourism, could connect the attractions, whether directly or indirectly. Graph 1 shows the levels of light pollution:

Graph 1 : Analysis of the Illuminance Indices of the Chosen Locations



	2012	2013	2014	2015	2016	2017	2018	2019	2020
Island	0	0	0,01	0,01	0,04	0,01	0,02	0,04	0,03
Belvedere	2,59	2,89	3,28	2,17	1,89	1,99	2,51	2,71	2,71
Rural area	0,01	0,03	0,04	0,02	0,01	0,03	0,04	0,02	0,05
City	37,14	36,55	38,91	32,97	35,74	39,55	39,69	38,32	34

Source: Light Pollution Map, 2021

The graph shows that it is possible to compare the chosen locations in the municipality of Rosana, and their respective light indices in an area, based on data collected by the VIIRS satellite, which is converted into units of magnitude of the sky background, at night, by arc second squared by the Light Pollution Map tool.

The result of the analysis showed that the attractions listed have low levels of light pollution. Therefore, they have natural potential, as the night sky is protected, as corroborated by Honorato & Violin (2020). The record of the light pollution indices in the town shows that there is still a high incidence of artificial light, impairing the quality of the sky, as without the nearby areas having adequate lighting, it will cause a noticeable visual interference in the region's sky, which can extend for several kilometers, affecting various locations beyond the urban area.

It is therefore indicated that the location has potential for astrotourism, especially considering the possibility of linking the attractions related to the region's rivers, generating income for the populations whose livelihoods depend on this type of offer, and expanding the offer of rural tourism, which presents scenic beauty, ease of access, and potential connectivity with the object of analysis of this study.

Finally, it is important to emphasize that converting the data collected by the satellite requires some specifications that would help make it more assertive in the quantification of the luminance of the night sky. For this, an analysis model would be needed, to find out how light propagates in the earth's atmosphere, taking into account several factors, such as the air condition and the curvature of the earth.

Final Considerations

The offer of astrotourism has potential for connectivity with other attractions in the municipality, and is a potential means of increasing the offer, as it gives the target audience (i.e. tourists visiting the municipality) or even the residents of the surrounding areas, the opportunity to access a specific type of experience.

Astrotourism as a tourist offer can, for example, connect with the activities already offered relating to the rivers that surround the municipality are already well-developed. It can also be combined with offers linked to rural tourism in the municipality, where there are already actions in place to boost demand.

This type of study contributes to the theory by furthering our understanding of the topic, expanding the scope of analysis, and opening up discussion on forms and types of supply in the field of tourism, with special emphasis on the possibility of understanding regarding the connection between astrotourism in rural areas, and the night sky as an indelible heritage to be contextualized and protected, so that the object of study can be used as an interpretive factor, enabling the segment to become a factor for enhancing tourism.

The study contributes to the field of understanding by launching the perception of coherence between the offer and the demand of a niche that is still unexplored in Brazil, but that has gained relevance in other countries, with the adoption of certification programs aimed at promoting astrotourism.

It is observed that from the management point of view, the study suggests the possibility of introducing structures for astrotourism, especially in rural areas, or even on islands, like the ones in the region analyzed, considering the low light and the relatively low costs of investment in the activity, which can be combined with other attractions or activities in rural areas, or even bird watching, for example, or even specialized offers focused exclusively on this type of activity.

The academic contribution of the study is the incorporation of understandings related to the form of studying indicators of light levels, and the form of triangulation of the variables used to understand how this type of niche is structured in the context of the tourist offer, especially in locations where tourism is not a key part of the local economy.

As an indication for future research, the scope of analysis could be expanded through a single or multiple case studies on the subject, in order to broaden the understanding of the elements that favor the offer of astrotourism in Brazil, given that it still it is an unexplored field of research, but an area in which the market is expanding.

The low light levels in the locations studied demonstrate passive potential that can be explored in the municipality. However, the town has high levels of light pollution, therefore this sector would need to be introduced with actions to combat the light pollution, safeguard the sky landscape, and enable it to benefit from the possibilities that astrotourism offers.

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